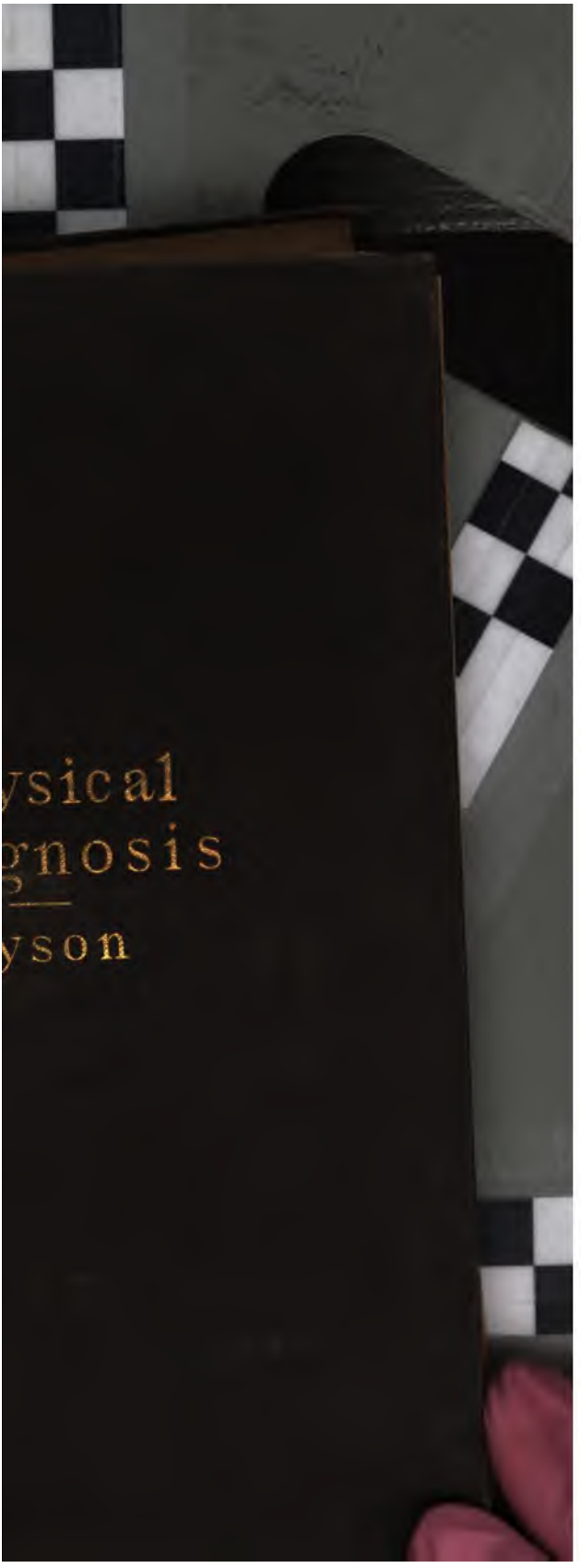
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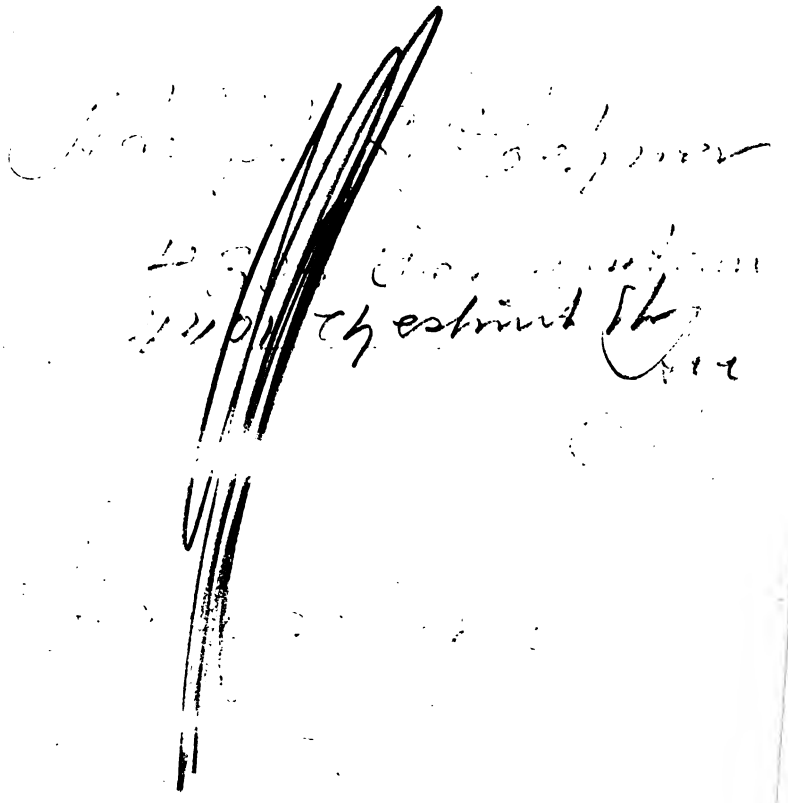

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OF

PHYSICAL DIAGNOSIS.

TYSON.

BY THE SAME AUTHOR.

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MANUAL

OF

PHYSICAL DIAGNOSIS

FOR THE USE OF

STUDENTS AND PHYSICIANS.

BY

JAMES TYSON, M.D.,

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PHILADELPHIA:
P. BLAKISTON, SON & CO.
1012 WALNUT STREET.
1891.

PRESS OF WM. F. FELL & CO.,
1220-24 SANSOM STREET,
PHILADELPHIA.

PREFACE.

It cannot be said that the making of a new book on Physical Diagnosis is demanded by reason of the fewness of existing treatises on the subject. It is, however, but natural that it should occur to one, a part of whose duty it is to teach physical diagnosis to large classes of medical students, that he might accomplish more satisfactorily his task by having a text-book of his own preparation. In this I have sought to secure conciseness with sufficiency, a task acknowledged to be difficult, but which experience in teaching is, perhaps, best calculated to overcome. It is the object I especially sought in my Manual on the Examination of Urine, which has now reached its Seventh Edition. The present book is not intended to be pretentious, and if it effects its simple purpose in being useful to students I will feel repaid.

1506, Spruce Street, October 1st, 1891.

LIST OF ILLUSTRATIONS.

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PHYSICAL DIAGNOSIS.

GENERAL CONSIDERATIONS.

The term physical diagnosis strictly defined would include the diagnosis or investigation of disease by the aid of all the special senses, but practically it is confined to eliciting such information as can be furnished by vision, touch, and hearing. Whence come the terms inspection, palpation and auscultation. The information acquired by hearing is further subdivided—1st. Into that gained by listening directly to the normal breathing sounds and heart sounds, and to their abnormal modifications; and to certain new sounds produced by diseased states. 2d. Information gained by striking or percussing the part to be investigated. Hence, too, the words auscultation and percussion are constantly used in association.

The information furnished by inspection is also rendered more accurate by measuring or mensuration, when this can be applied. Thus constituted, physical diagnosis is applied to any portion of the body, but it is more especially in the study of diseases of the thoracic and abdominal contents, and particularly the former,

that it is useful. The phenomena thus learned are known as physical signs. The use of the term "physical" is explained by the fact that it is through alterations in the physical properties of the tissue or organ investigated that information is obtained. On the other hand, in its usual application there is a restriction inconsistent with strict accuracy. Thus there is no more accurate means of recognizing physical states than by thermometry, yet thermometry is not one of the measures included under the head of physical diagnosis.

It is very true that physical signs cannot be acquired from books and must be learned at the bed-side; but we may record their import and significance in the recognition of disease and render somewhat easier their study. To this end is indispensable a familiarity with the physical condition of the organs of the body in a state of health. This, too, can only be learned on the living subject by giving the student an opportunity to listen until he is thoroughly familiar with the normal breathing and heart-sounds, to observe the shape and configuration of the body, and to learn the percussion note characteristic of different regions over important organs, as the heart, lungs and various abdominal viscera. Such a study of the situation of internal organs in relation to external parts, for the purposes of the physician, constitutes medical anatomy.

The attainment of the objects of physical diagnosis is greatly facilitated by mapping out the chest into certain spaces or areas known as the

REGIONS OR SPACES OF THE CHEST.

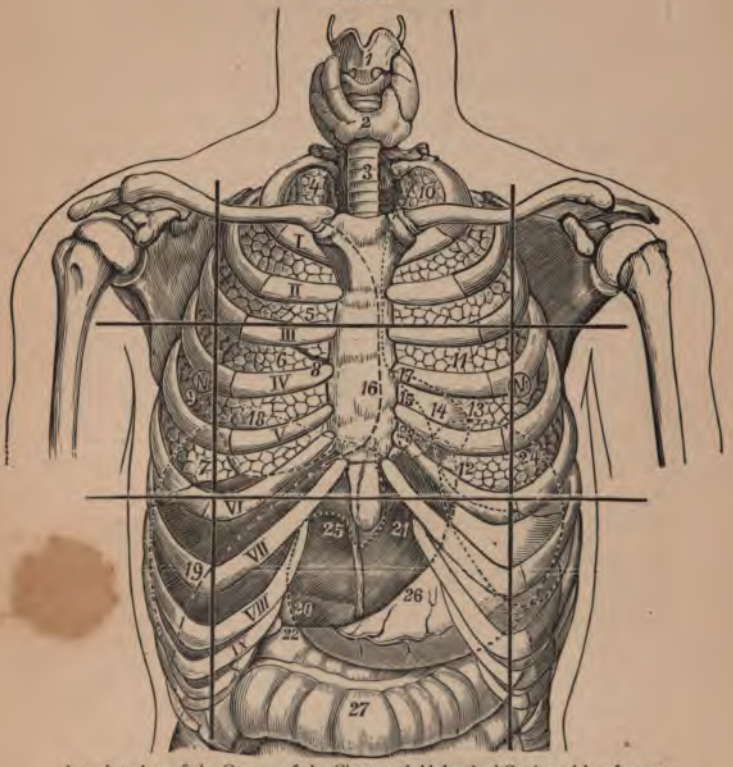
The **clavicle** itself is a useful landmark in physical examination, while above each clavicle in health is usually a slight depression known as the **supra-clavicular fossa**, and above the sternum another known as the **supra-sternal notch**. Below each clavicle is the **infra-clavicular space**, which is somewhat arbitrarily bounded below by the upper edge of the third rib and adjacent cartilage, internally by the edge of the sternum and externally by the base of the shoulder or a line drawn vertically from the inner end of the outer fourth of the clavicle. Below the clavicle, as well as above, in health, is usually a slight depression. All these depressions or spaces are liable to become deeper from emaciation, and are less conspicuous in fat persons. Below the upper edge of the third rib is the **mammary region**, bounded internally by the edge of the sternum, externally by the above described vertical line, and below by the upper margin of the sixth rib. Nearly in the centre of the mammary region is the nipple, which in males and young girls is just below the fourth rib. A line drawn vertically through it is known as the **mammillary line**. Below the mammary region, as far as the edge of the thorax, is the **infra-mammary region**. In the centre of the thorax anteriorly is the sternum, bounded by its notch above and the end of the ensiform cartilage below. It is divided into the **upper sternal region**, extending as far as a line drawn along the upper edge of the third rib, and the **lower sternal**, including the remainder of

the bone. Laterally are the **axillary** and the **infra-axillary** regions, separated by a line continuous transversely with the lower border of the mammary region, and bounded in front by the posterior border of the mammary and infra-mammary regions and behind by a line drawn vertically downward from the insertion of the posterior fold of the axilla. The infra-axillary region extends below to the edge of the thorax.

Posteriorly are the **supra-spinous fossæ** of the scapulæ, the **infra-spinous fossæ**, the **interscapular** region and the **sub-scapular** or infra-scapular regions. The first four are sufficiently indicated by their names; the interscapular region is included between the scapulæ posteriorly and bounded below by a line drawn through the angles of these bones in the position assumed by them when the arms are hanging at the side. Such line crosses the seventh rib. The infra-scapular regions are bounded above by the line just described, below by the edge of the thorax, and extend from the median line to the posterior axillary line on each side.

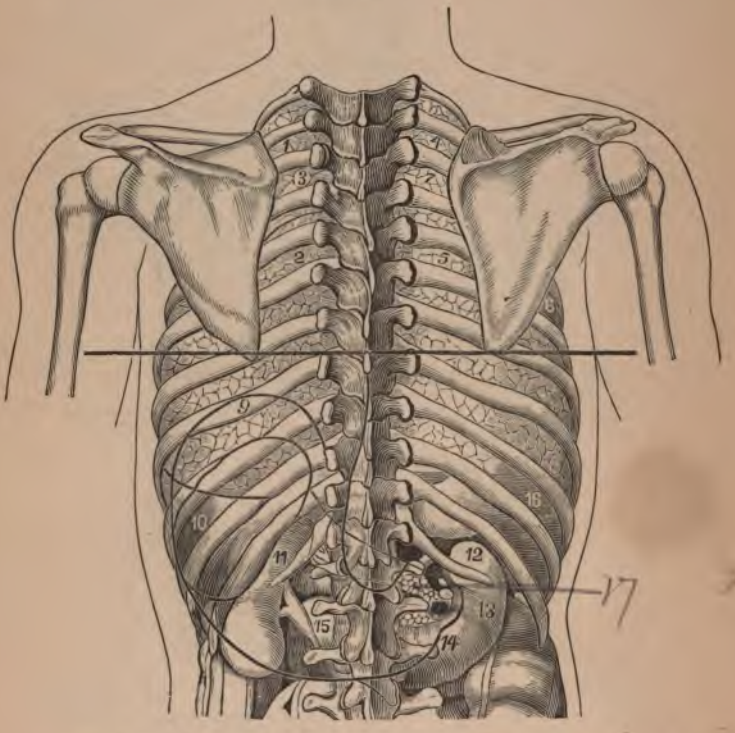
In addition to the mammillary line are lines drawn vertically down the middle of the axilla and through the angle of the scapula behind, called the **mid-axillary** and **scapular** lines—also landmarks useful in description. The **parasternal** line, sometimes used, is a vertical line drawn midway between the edge of the sternum and the mammillary line.

FIG. 1.



Anterior view of the Organs of the Chest and Abdominal Cavity with reference to their relations to the skeleton and the boundaries of the stomach. 1. Larynx. 2. Thyroid gland. 3. Trachea. 4. Right lung-apex. 5. Upper lobe, 6. Middle lobe, 7. Lower lobe of right lung. 8. Upper, 9. Lower, interlobular boundary of the right lung. 10. Apex, 11. Upper lobe, 12. Lingual process of the left lung. 13. Cardiac boundary of the anterior border of the left lung. 14. Portion of the anterior aspect of the pericardium covered by the cardiac pleura. 15. Portion of same uncovered by diaphragm. Site for paracentesis. 16. Anterior border of right mediastinum. 17. Anterior border of the left mediastinum. 18. Upper or true border of the liver partially covered by lung. 19. Right lobe of the liver. 20. Quadrate lobe of the liver. 21. Left lobe of the liver. 22. Gall bladder. 23. Upper end of the stomach. 24. Stomach cul du sac partially covered by lung. 25. Pyloric end of stomach. 26. Larger curvature of stomach (right gastro-epiploic artery). 27. Transverse colon.—*After Paul Niemeyer*, slightly modified.

FIG. 2.



Posterior View of the Organs of the Chest and Abdominal Cavity. 1. Upper lobe, 2. Lower lobe of left lung. 3. Interlobular boundary between them. 6. Middle lobe of the right lung. 7. Line between upper and middle lobes of the right lung. 9. Stomach demarked by a dark line. 10. Spleen in its relation to the lung in expiration, with the kidney showing behind and below it. 11. Left kidney. 12. Horizontal upper part of the duodenum. 13. Descending portion of the duodenum. 14. Horizontal part, lower duodenum. 15. Duodeno-jejunal flexure. 16. Liver. 17. Pancreas.—*After Paul Niemeyer.*

INSPECTION AND MENSURATION.

The appearances of the regions described, during and independent of the motions of breathing, are objects of inspection, but these are best described in connection with the conditions which modify them. In inspecting the chest from the front or behind, the patient should stand erect with the hands at the side; during lateral inspection the hands should be raised alongside of the head, or they may grasp opposite shoulders. Such relations to light should be chosen as will obviate shadows as much as possible. It will be remembered that during breathing [illegible] exhibit more motion in the upper part of the chest, while in [illegible] abdominal motion is marked.

Mensuration is for the most part practiced by an ordinary tape measure, and thus the circumference of the chest at different situations is determined; also differences in the circumference at the end of inspiration and of expiration, and differences in the semi-circumference as the result of abnormal states. It is to be borne in mind that in right-handed persons the semi-circumference of the right side is often half an inch or more greater than that of the left, owing to the greater muscular development of that side. The reverse obtains in left-handed individuals. The transverse diameter of the chest may be determined by a pair of calipers; any deviations in the shape of the chest by the cyrtometer, a simple form of which may be made out of strips of sheet lead, moulded to the chest-walls, and the outline

thus produced be drawn on a large sheet of paper. More perfect appliances for chest measurement are the stethometer of Quain, the stetho-goniometer of Allison, the cyrtometer of Woillez, and others, but they are not needed for the usual measurements.

PALPATION.

After inspection and mensuration of the chest, palpation is usually practiced. This is done by applying the palm of the hand or the fingers, as may best serve the purpose, to the chest-wall. The chief value of palpation lies in the fact that when the hand is thus closely applied, and the person "touched" speaks, a peculiar vibrating or trembling sensation is conveyed to the hand. This is known as **vocal fremitus.** This fremitus or thrill, representing the vibrations in the air below the vocal cords, is communicated to the walls of the air passages, from the larger to the smaller, until the ultimate structure of the lung is reached, whence it is conveyed to the chest-wall and hands. In health it is felt everywhere over the chest where lung-tissue reaches, but is more distinct where the chest-walls are thinnest, and especially in the right infra-clavicular space as compared with the left, an important fact to be remembered in recognizing delicate shades of difference. This is usually explained by the fact that the right bronchus is shorter, larger, and enters the lungs higher up and more horizontally than the left, whence a larger volume of air is contained in the right lung,

especially in its upper portion, and stronger vibrations are produced in speaking. For the same reason tactile fremitus is sometimes slightly more distinct posteriorly in the right half of the interscapular space, and even below the angle of the scapula. In the axilla the same difference exists to a less degree. Tactile fremitus is, of course, more marked in persons with thin chest-walls than in those with thick muscular walls, or walls covered with fat, while it is feebler but still easily appreciable in women. It is also greatly influenced by the pitch or tone of the voice used, being more marked in a deep, low-toned speech than in a high one. It is further influenced by words selected for utterance. My favorites are "ninety-nine," as producing a longer vibration than words like "sixty-six," for instance. But "one, two three," or "twenty-one," "twenty-two" and "twenty-three," and the like, are useful also to bring out vocal fremitus.

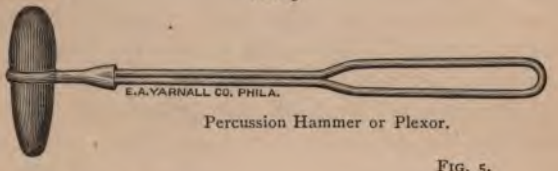
Vocal fremitus is increased in abnormal states producing consolidation of the lung, as in pneumonia and tubercular deposit, and is diminished by conditions which separate the lungs from the chest-wall, as pleuritic effusions, and even solid tumors.

Fremitus is also produced by the action of coughing, when it is called **tussile**, as distinguished from vocal; by râles, dry or moist, if the tubes are of sufficient calibre, when it is called **rhonchal**; also by pleural and pericardial frictions.

PERCUSSION.

Percussion naturally succeeds inspection, and consists in striking a part with a view to eliciting sound. In its simplest form it is probably as old as medicine, but Auenbrugger, of Vienna, was the first to publish, in 1761, results obtained from its application. Percussion is called **immediate** or **mediate**, according as the

FIG. 3.



Percussion Hammer or Plexor.

FIG. 4.

Ivory Pleximeter.

FIG. 5.

Sansom's Pleximeter.

blow is struck directly upon the part or upon some interposed medium. Immediate percussion is of limited application, but it is still sometimes very useful, and I much like to percuss the clavicular region by striking directly the bone rather than upon some interposed substance. The hammer or agent by which the stroke is practiced is the **plexor**, and the interposed material is

the **pleximeter.** By far the most common plexor, and for the most part the best, is the middle or index finger, or both of these, while one or the other of the same fingers of the other hand becomes the pleximeter. It is often useful, however, to have a specialized hammer, like that figured in the text, while more useful and even more indispensable at times becomes a pleximeter, in situations which the fingers cannot conveniently reach, or where there is much percussing to do, when the fingers sometimes become sore and tender, from the constant pounding. By far the most satisfactory pleximeter, in my experience, is the little hard-rubber pleximeter suggested by Sansom, and figured in the text. Either the larger or smaller end may be applied to the chest, and the stroke given to the other side, with equal efficiency.

The pleximeter was invented and first used by Piorry, of Paris, in 1828, and the hammer by Wintrich, in 1841.

The essential conditions of successful percussion are, first, the close application of the pleximeter, whether it be the finger or an artifieial pleximeter, to the chest, so that it will form a part, as it were, of the area to be percussed; and, as the two sides of the thorax are commonly compared, precisely corresponding points should be selected. Then care should be taken to strike with equal force on each side. When the fingers are used as plexors, the stroke should be made from the wrist, and vertically on the pleximeter, while the hand should be raised quickly, and one, two, three or more blows given until the proper sound of the part is elicited. To this

end the stroke should be neither too forcible nor too feeble. When the proper note is brought out it should be remembered and compared with the sound elicited under the same conditions at the corresponding point on the opposite side. Practice with attention to these conditions can alone make perfect.

The sound produced by percussing the chest is a mixed one, made up of the vibrations of the pleximeter, those of the thoracic wall and those of the air in the lungs. The first, when the finger is used as a pleximeter, is scarcely noticeable, but when a pleximeter of ivory or hard rubber is used this element may be recognized, especially when the pleximeter is accidentally struck by the nails of the finger used as plexor. In like manner the vibrations of the thoracic wall are insignificant and unnoticeable under ordinary circumstances, in comparison with the vibrations of the air in the lungs, which are responsible for most of the sound produced in percussing the normal chest. These vibrations are set up by the blow, and it is the sound thus produced, variously modified in health and disease, which we are to study.

Auscultatory percussion is a term applied to a method introduced by Cammann and Clark, which consists in listening, with a stethoscope applied to the chest-walls, to the sounds obtained by percussion.

Respiratory percussion is a term proposed by DaCosta for the study of a note made by percussion while the breath of a patient is held, after a deep inspiration or after a prolonged expiration. Constant reference will be made to the effect of the latter on sounds elicited by percussing normal organs.

ATTRIBUTES OF PERCUSSION SOUNDS.

Percussion sounds have attributes of **quality, intensity** or **loudness, pitch** and **duration.** None of these attributes can, strictly speaking, be so described as to enable it to be recognized by the ear. Practice and illustration must be associated with the description in order that an adequate idea may be obtained.

Quality is the easiest indicated of the attributes of sound. Although Flint correctly says of it that "to attempt to describe the quality of sounds to one who has never heard them would be like describing colors to one who is blind," illustration happily comes to our assistance and helps greatly. Thus it is not difficult for any one who has heard it to recognize the note of a violin or piano and to name the instrument producing it. The attribute by which such recognition is made is quality of sound, and each quality is produced by certain conditions peculiar to the instrument producing the sound. It varies therefore with those conditions.

Now the qualities of sound produced by percussing the normal chest are mainly two: 1st, *the normal vesicular resonance or clear sound;* 2d, *the dull sound or dullness.* A third quality, not strictly speaking a normal thoracic sound, but so conspicuous in adjacent organs in health as to often influence the thoracic sounds, will also be described in this connection. I allude to *tympany.* Each of these is produced by conditions peculiar to itself.

The term **vesicular resonance** or clearness as applied to the healthy chest is produced by percussion

over a structure containing air in minutely divided spaces. Such structure is its condition, and the sound produced is as much *sui generis* as is the violin's sound. It is of the nature of a reverberation and is reverberation modified by minute subdivision of air spaces. It is not inaptly compared by Flint to the sound produced by percussing a loaf of bread over which a towel has been spread, the upper crust of the bread corresponding to the chest-wall; but, as a rule, normal resonance is characterized by less hollowness than the percussion of a loaf of bread. It differs in different parts of the chest of the same individual, and in different individuals. Its typical quality may be found in either infra-clavicular space or below the angle of either scapula in persons with chest-walls of moderate thickness.

The chief cause which operates to produce the differences alluded to is the varying thickness of the chest-walls; but the state of tension of the air in the air vesicles has also to do with it, as has also the position of adjacent viscera and the mode of percussion, according as it is forcibly or lightly practiced, according as it is well or faultily done. These differences are the direct result of the changes in the other three attributes named, intensity, pitch and duration.

Intensity means simply loudness and increases *pari passu* with the thinness of the chest-wall and the force of the percussion blow. The effect of the attributes of pitch and duration are best studied after the other qualities mentioned, dullness and tympany, are considered.

Dullness in general may be defined as diminished

resonance, but the term is not used by all authors with a single meaning. Thus DaCosta says,* "a dull sound denotes the absence of air. It is the sound both of fluids and solids. It is, thus, the sound sent forth by the airless viscera; from the liver, spleen and heart." Others, however, as A. Flint, Sr., E. T. Bruen, F. C. Shattuck, would use the term "flatness" to indicate this condition, exhibiting its typical note in percussing the thigh. R. C. M. Page† applies the term flatness to the quality obtained by percussing over fluids contained in thin walls, and presumably also, over pure solids. To retain the word flatness for the sound produced by percussing an absolutely airless organ or fluid, and dullness for resonance diminished in positive degree, gives a desirable latitude in the use of terms, further increased by the application of the adjective terms slight, moderate, considerable or marked. I shall therefore use the term in this sense. Dullness and flatness are both associated with increased resistance to the percussing finger, a sign also more or less valuable in diagnosis.

Tympany or **tympanitic resonance** is the sound elicited by percussing over a large cavity filled with air—a cavity whose walls are rather thin, and neither very tense nor very yielding. The stomach and intestines furnish such a cavity, and it is in this region that we seek the tympanitic quality of resonance. Tympany also has variations due to the size of cavities and to pitch,

* "Medical Diagnosis," 7th ed.; 1890, p. 264.

† "Physical Diagnosis," 3d ed.; p. 23.

which will be better understood after this attribute of sound is considered.

We are now ready to discuss and illustrate the attributes of pitch and duration, neither of which are so easily described as quality and intensity. They can indeed only be learned by practice and with varying facility by different ears, the musical ear having a decided advantage. Perseverance, however, will enable any one to appreciate them sufficiently for practical purposes.

First as to **pitch.** We speak of it as high or low and of intermediate degree. Pitch is higher the more rapid is the succession of the vibrations of the sounding body and of the sound waves which emanate from it, while intensity depends on the amplitude or extent of these waves. Shrillness is the acme of pitch, loudness of intensity. The higher the tension of a percussed cavity containing air the more numerous the vibrations and the higher the pitch, but the shorter the vibrations and the less the intensity. *Vice versâ*, a high pitched tympanitic resonance would indicate a smaller cavity with tenser walls than low pitched tympany. The normal vesicular resonance is characterized by its low pitch, because the air vesicles, from their elasticity, are not in a state of high tension. If, however, the lungs be forcibly dilated, the air vesicles are placed in a state of higher tension and of diminished elasticity, a situation akin to that of a distended stomach, and if percussion be now practiced over such areas the pitch will be raised, but there will be added not only a higher pitch, but also a tympanitic

quality, and a note will be produced which was named by the late Dr. Flint **vesiculo-tympanitic resonance.** It is a mixed note, therefore, and its conditions are produced by any cause which over-distends the air vesicles, as prolonged crying in a child. It is also the note of the over-distended air vesicles in emphysema of the lung or of portions of a lung, supplementally active in consequence of impairment of function in other parts. A tendency to vesiculo-tympanitic resonance also exists at the right apex of the lung as compared with other situations of typical resonance, and is recognized by the shadowy higher pitch sometimes noticeable in that locality. Tympanitic sounds, although generally high pitched, also vary in pitch, the latter increasing inversely as the size of the cavity and directly with the degree of tension. Thus the stomach being a large cavity gives on percussion a lower pitch than the small intestine distended to an equal degree. On the other hand, tension may be made so great by forcible distention, say of the stomach, that the tympanitic sound may be destroyed. In the moderate distention which gives us good tympany, the stomach wall is not tense enough to be thrown into vibrations, the air within the cavity alone vibrates and true tympany results. If, however, the distention is excessive, percussion throws both walls and contained air into vibration, and the two sets of vibrations interfering with each other a non-tympanitic muffled sound results. If, again, the walls of a cavity are so firm that they cannot vibrate at all, a modified tympany results which is called amphoric, to be again

referred to. Indeed, the stomach note obtained on percussion is often rather more amphoric than tympanitic.

Dull and flat percussion are high pitched in their note, and the pitch increases with the dullness and the area of the dullness, while the first suggestion of impaired resonance is a slight heightening of pitch which the practiced ear readily recognizes, and attaches to it great importance. The tendency to higher pitched note just below the right clavicle as compared to the left is also to be remembered in weighing slight differences in the percussion note of the two sides. It is associated with the tendency to increased vocal fremitus in the same situation, already referred to.

The explanations of this tendency to slightly higher pitched resonance and slight dullness at the right apex are not uniform, and are therefore best considered in a foot-note.*

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* First is the explanation of Flint, who, in ascribing it to a special character of vesiculo-tympany, implies some change in the elasticity of the air-vesicles. How this is brought about except by some greater functional activity of the right apex I do not know.

The second explanation of this slight impairment of the resonance is based on the different arrangement of the bronchial tubes on the right side as compared with the left. The former are larger, extend higher up than the latter, and thus give us more tubular tissue, including a larger proportion of connective and muscular tissue to deal with in percussing, which would give us slightly less resonance.

A third explanation, which certainly must be allowed to apply in some instances, is the greater muscular development of the right side of the body, and in consequence greater thickness of the pec-

Duration is the attribute of least importance. It varies inversely with the pitch, that is, the higher the pitch the shorter the duration, and *vice versâ*.

We are now ready to study the percussion sounds as heard in the different regions of the chest as already mapped out.

PERCUSSION OF THE NORMAL CHEST.

First, in the **supra-clavicular spaces.**

Satisfactory percussion here is difficult and results are not to be too much relied upon. The nearest approach to normal clear percussion or vesicular resonance is found above the centre of the clavicles where the lungs rise from half an inch to an inch and a half or even two inches above the clavicle, being usually higher in women than in men. Towards the inner end of the clavicle the percussion may acquire a more tympanitic quality, on account of the proximity of the trachea, while towards the outer end a duller note obtains.

On the **clavicles** themselves percussion is clear, almost typically so, over the middle of the bone, but

---

toral muscles of that side. This would also cause a slightly higher pitch. The opposite state of affairs in left-handed persons would go far to confirm this, but I am not aware of any systematic observations intended to settle this question.

Still another explanation of this difference is based on the fact that the right lung rests, through the diaphragm, upon the right lobe of the liver, which is a dense organ, and percussion of the lung would be modified, by such relation, towards a slight impairment of resonance. It is not impossible that any one or more of the first three causes might operate to produce the difference on the two sides.

becomes duller as the outer end is approached, while on the inner end it may be higher pitched.

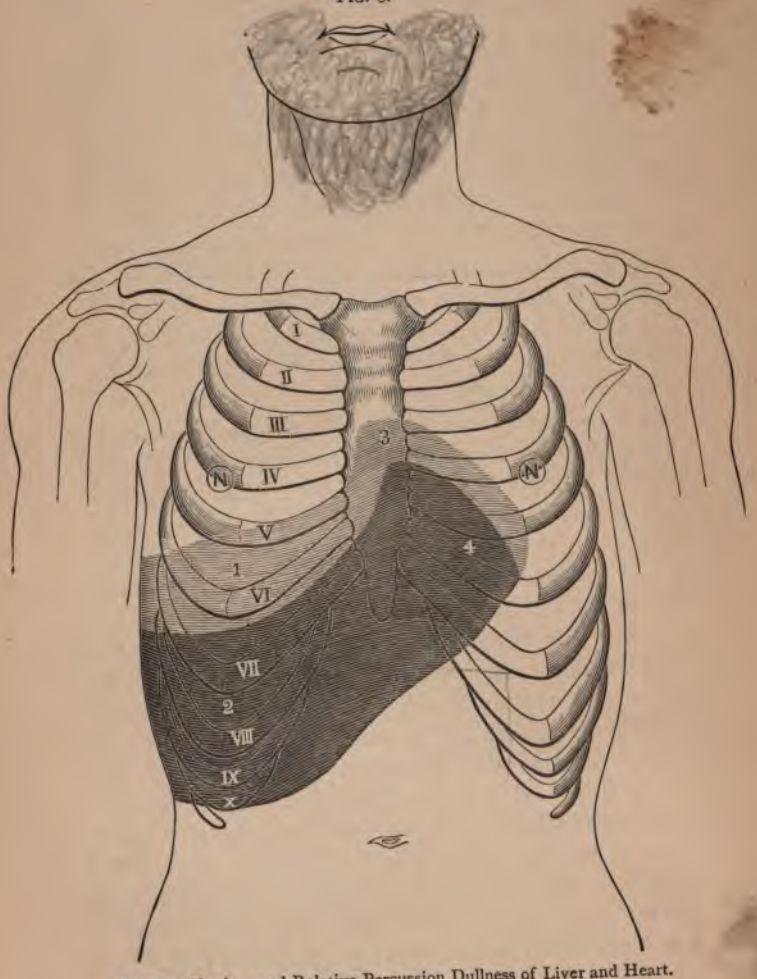
The **infra-clavicular spaces** furnish in health the typical clear percussion-note or vesicular resonance as far as the upper edge of the fourth rib; on the right side is to be looked for the shadowy higher pitch, the vesiculo-tympany of Flint, so that Page selects the left subclavicular as the typically normal. This difference is not invariable, but the fact is to be remembered in weighing shades of difference with a view to diagnosis.

In the **mammary region** percussing down the right mammillary line, the clearness continues, possibly a trifle less on account of the greater thickness of the pectoral muscle until the fourth interspace or the fifth rib is reached, when there is a raised pitch and diminished intensity which passes at the sixth interspace or seventh rib into a positive dullness, which continues in health to the edge of the ribs. This impairment of the resonance on the right side is due to the liver, the lesser degree being known as the deep or *relative* dullness, and below this the *absolute dullness*. The upper border of the absolute dullness corresponds with the lower edge of the right lung. Close to the sternum on the right side there may be slight impairment of resonance, due to the relative dullness of the right auricle and ventricle, beginning with the third rib and passing at the fifth into the relative dullness of the liver, and at the sixth into the flatness of that organ. On forced inspiration the liver is pushed downward an inch or more, and on forced expiration there is a corresponding rise.

On the left side, close to the sternum, normal vesicular resonance begins to lessen at the third interspace, owing to the deep or relative dullness of the heart, and at the fourth costal cartilage is replaced by the absolute dullness of this organ, which continues down along the left edge of the sternum until it passes into the left lobe of the liver, from which it cannot be demarked; but in general terms the cardiac dullness may be said to extend from the fourth to the sixth rib, and from the sternum to a curved line extending a short distance along the fourth cartilage and thence down within the nipple line to the seat of the apex beat. The cardiac area of dullness is also diminished on deep inspiration, because the organ becomes more fully covered by the distended lungs. Without the nipple in both sides there is, in health, resonance to the anterior axillary line, slightly lessened by the mammary gland and pectoral muscle.

The **infra-mammary** or **hypochondriac** region on the right side is wholly occupied by the liver and furnishes flat percussion. The width of the area of absolute dullness of the liver is about three inches. On the left side the percussion in this region varies greatly in different persons and in the same person at different times. Towards the sternum the left lobe of the liver for the most part maintains its dullness, but even this is sometimes replaced by the tympany of a dilated stomach, while to the outside of this, the stomach as normally distended with gases quite frequently imparts a tympanitic note. On the other hand the presence of solids and fluids in the stomach in varying amounts contributes

FIG. 6.



Showing Absolute and Relative Percussion Dullness of Liver and Heart.

dullness. A spleen of normal size does not extend into the infra-mammary region. In this connection it may be said that the lower edge of the liver generally corresponds to a line drawn from the sixth rib within the left mammillary line obliquely across the epigastrium to the junction of the right mammillary line with the edge of the thorax.

In the **supra-sternal notch**, also difficult to percuss, tracheal tympany may be brought out by vertical percussion on a suitably placed pleximeter. Over the **upper sternal** region, as far as the third rib, the percussion is resonant, with a slightly tympanitic note communicated by the trachea. Below this for a short distance there is a purer lung note. At the fourth rib the heart, though covered in by the lungs, begins to deaden the note, but it is still clear until the liver is reached at the sixth rib, where dullness is absolute and extends in the median line half way to the umbilicus, although a tympanitic stomach may also influence this.

In the **axillary spaces** on both sides there is good pulmonary resonance. In the infra-axillary of the right side, the relative dullness of the liver is noted at the seventh rib on the mid-axillary line and the absolute dullness at the eighth, but sometimes at the ninth. On the left side there is also clearness until the spleen is reached in the mid-axillary line at the seventh rib, whence it extends to the ninth. Laterally the spleen extends upwards and backwards between these two ribs from two to three inches, and sometimes it is so covered in as to escape careful percussion. The left infra-axillary region

is also apt to be encroached upon by the tympany of the stomach.

Posteriorly. Percussion is best practiced with the patient leaning slightly forward and folding his arms. The upper border of the lungs behind is on a level with the spinous process of the seventh cervical vertebra.

In the **supra-spinous fossa** the percussion resonance is markedly less than the typical, because of the bone and the thick muscles overlying it, and the same may be said of the infra-spinous region. At the same time percussion here is important because differences on the two sides are usually easily recognizable.

In the **interscapular** region there is again better resonance than over the scapulæ themselves, but still less intense than below the angles of the scapulæ, on account of the tolerably thick muscles and the spinal column. In the upper portion the tympany of the trachea may influence the note.

In the **infra-scapular** regions we have the nearest approach behind to the typical resonance as represented by the left infra-clavicular space. The information obtained here by percussion is most valuable, only second in importance to that obtained by percussing below the clavicles, and in consequence of this it is important to remember the inferior border of the normal resonance. The lower border of the lung on both sides corresponds to the tenth rib, where, on the right side, the absolute dullness of the liver is found, while the relative dullness on strong percussion is found a rib higher. On the left side resonance extends in the

line of the angle of the scapula fully to the tenth rib, though sometimes a tympanitic quality may be imparted by a dilated stomach or the colon, or a slightly dull sound if the spleen extends a little farther back than usual. Here as elsewhere on the thorax there may be slightly less intensity, and slightly higher pitch on the right side, on account of the greater muscular development in right-handed persons, and the effect of a deep inspiration on lowering the resonance, and in expiration of raising it an inch or more, is also to be remembered. In ordinary breathing the normal resonance posteriorly passes at the tenth rib into the absolute flatness of the lumbar region.

The upper border of the **kidneys** under the eleventh rib, the left being a little higher than the right, cannot ordinarily be separated by percussion from the dullness of the spleen and liver, nor can the inner border be separated from the spinal column. The outer edge can, however, be defined, by percussion, from the colon on the right and the stomach on the left, by percussing outwards from the median line behind. The outer border of the kidney is about three or four inches beyond the median line. The lower border can sometimes be defined by a line of tympany just above the crest of the ilium. Forcible percussion is required, and it is desirable to place a pillow under the abdomen of the patient lying prone upon his face.

ABNORMAL PERCUSSION LUNG SOUNDS.

It goes without saying that a sound which is normal in one situation becomes abnormal when heard in a position unnatural to it in health, as dullness or tympany below the clavicles or below the angles of the scapulæ, where vesicular resonance is ordinarily heard. But in addition there are certain positive modifications of normal sounds not heard anywhere in health, or at least under such exceptional conditions as do not permit them to be included among normal sounds.

These are **vesiculo-tympanitic resonance, amphoric resonance**, and **cracked-pot sound.**

Vesiculo-tympanitic Resonance.—The vesiculo-tympanitic resonance of Flint has already been alluded to, but requires to be further considered because it is not generally recognized by either American, English or German authors, as something distinct and different from tympany, and it requires to be conformed to their treatment of conditions supposed to cause it. In the language of its describer "the resonance increased in intensity; the quality a combination of the vesicular with a tympanitic, and the pitch higher in proportion as the tympanitic quality predominates over the vesicular." According to him also the morbid condition which especially illustrates this form of resonance is the over-dilatation of the air vesicles which constitutes vesicular emphysema of the lungs, but it is also present in interstitial or interlobular emphysema. Also, over the upper lobe of a lung when the lower lobe is solidified in the second stage of pneumonia, and over

the lower lobe when the upper is solidified. So, also, if the lower part of a pleural sac contains fluid, even though the volume of the lung is diminished, the upper part of the same lung may give the same vesiculo-tympanitic note.* Too much of the intra-thoracic space must not be occupied, as the lung is thus compressed and rendered airless, but the resonance is vesiculo-tympanitic above the liquid when the latter is sufficient to fill a third, a half or even two-thirds of the intra-thoracic space.

Now these are essentially the conditions named by Da Costa, Paul Niemeyer and Graham Brown as producing *tympanitic* resonance of lung tissue. Says Brown,† "just as when the lung is removed from the body and allowed to collapse it gives a tympanitic note, so when a similar retraction and relaxation of the pulmonic tissue takes place within the thorax, that variety of percussion note may be heard. This is best marked in cases of pleuritic effusion which, gravitating to the lower portion of the cavity, floats up the lung and causes relaxation of the upper portion. When the effusion is small in amount the tympanitic note can only be detected over that portion of the lung which lies immediately above the upper limit of the fluid, but when the effusion is considerable the whole upper lobe may be tympanitic on percussion. Similarly, effusion into the alveoli in

* This is what is known as Skoda's sign.

† "Medical Diagnosis", 3d edition, Edinburgh, 1887, page 207.

pneumonia or œdema may produce a like result." * Niemeyer† adds, occasionally gangrene and infarct, also disseminated tubercular infiltration, emphysema and nervous asthma, and that portion of the lung not inflamed but immediately adjacent to a hepatized part. In like manner phthisical consolidations of the apices may also occasion an obscurely tympanitic note over neighboring portions of the lung. Finally, Da Costa, who with Flint may be regarded as representing the American School, says, "but generally a tympanitic sound over the seat of the lungs is expressive of emphysema or of pneumothorax, or sometimes of a cavity or of œdema of the lungs. Again, as Skoda has taught us, it occurs in moderate pleuritic effusions above the level of the liquid."‡

It has seemed to me important to contrast these statements, both in order to give a better idea of what Flint intends to convey by vesiculo-tympanitic resonance and to avoid confusion in the minds of those who might with reason be confused by statements apparently so diverse. That there should be something different from typical tympany in the percussion note produced under the circumstances named seems likely, yet I am by no means

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* This can occur only in the first and third stages of pneumonia when the air vesicles contain air, the second stage being one of absolute airlessness and dullness.

† Grundriss der Percussion und Auscultation. Zweite Auflage. Erlangen, 1873, pages, 38, 39.

‡ "Medical Diagnosis," 7th edition, 1890, page 265.

certain that the words *exaggerated resonance* or *hyper-resonance* would not convey the idea sufficiently well.

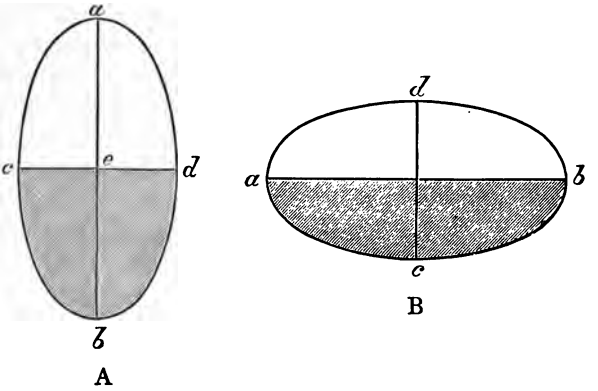
Pure Tympanitic Resonance.—Tympanitic resonance is found in normal thoracic states only over the larynx and trachea and in the left infra-axillary region from encroachment of a tympanitic stomach. Elsewhere it becomes a sign of an abnormal state.

In the chest, tympany is produced first in percussing over air-containing cavities in the lung tissue, sufficiently near the surface and sufficiently large, and whose walls are not too tense. As these cavities usually communicate with a bronchus they are further characterized by differences in the pitch when percussed with the mouth open or closed. This is Wintrich's change of note, according to which percussion over a given cavity gives a higher-pitched tympanitic sound with the mouth open than when it is closed. This may be illustrated by percussing over the thyroid cartilage under the two conditions, when the difference will be very evident. It occurs in connection with superficially placed cavities in communication with a bronchus. If this change of sound is observed on lying down, but is not on sitting up, or *vice versâ*, it means that the bronchus leading to the cavity is obstructed in the position in which the Wintrich change of note does not occur. This is the interrupted change of note of Wintrich.

Approximate estimates as to size and shape of cavities may be even made by observations as to pitch. Thus a cavity of small size will give a higher-pitched tympanitic note than one of a large size. Through Gerhardt's

change of note we learn something about the shape of cavities. Cavities which have unequal diameters, or are oval in shape and are partially filled with fluid, alter their note on changing the position of the patient from sitting to horizontal. Thus suppose A to represent an oval cavity in the vertical position with the contained

FIG. 7.



To illustrate Gerhardt's change of note.

fluid at the line *c d*. If the patient lies down the long diameter will become horizontal as in B and the level of the fluid will fall to *a b*. The percussion note is lower when the longer diameter is horizontal, higher when it is vertical. If, therefore, the percussion note is lower when the patient is sitting up, the direction of the longer

diameter is antero-posterior; if it is higher while sitting up the long diameter is vertical.

Every cavity does not, of course, furnish the conditions of tympanitic percussion.

Second, pure, tympanitic resonance is also characteristic of pneumothorax if the distention is not too great. There being no communication of such a space with a bronchial tube, no change of pitch is produced on opening and closing the mouth, but if there happens to be liquid in the sac, Biermer's change of note may be produced as follows: In the vertical position of a pneumothorax containing fluid the cavity is larger because the weight of the fluid pushes the diaphragm downwards. Hence in this position the pitch is lower. If the position of the patient is now changed from the vertical to the horizontal the cavity becomes smaller by reason of the changed position of the fluid and the pitch becomes higher.

Third, a pure tympanitic resonance may be produced in pneumonia and pleurisy, when the hepatization is so complete or the pleuritic exudation in such close relation with the lung that percussion throws into vibration the air in the trachea and bronchi.

Amphoric Resonance.—Amphoric resonance, a variety of tympanitic resonance, is a high-pitched metallic resonance, so called from its resemblance to the sound produced by striking the side of a jar, either empty or containing a small quantity of fluid. It may also be imitated by filliping the cheeks when the mouth is distended with air. It is an echoing sound, the waves

being reflected from side to side of the closed vessel, as speech in a vaulted chamber. Amphoric resonance is said to be produced or intensified by what is known as the bell-metal test of Gairdner, in which a coin of sufficient size is percussed by means of another on the anterior surface of the chest, while the auscultator listens posteriorly.

The conditions of its production in the human body are an air-filled cavity of considerable size with firm and smooth walls, completely closed or communicating with the air by a small opening only. These conditions are fulfilled by certain phthisical cavities, and especially by pneumothorax or pyopneumothorax. If with such a pyopneumothorax the body be shaken, the splashing or **succussion** will somehow have the same ringing character.

The Cracked-pot Sound.—This sound is well-named because it quite resembles that produced by tapping a cracked jar, and is therefore one of the most distinctive and easily recognized of the abnormal percussion sounds. It is, too, a modification of tympany, and is caused by the sudden expulsion of air from a cavity through a small opening by a sudden forcible blow. It is also imitated in mechanism as well as character by suddenly striking the back of the two palm-apposed hands against the knee, after the method used by the boys to imitate the clinking of coins.

It may also be made by striking the pleximeter when the latter is not closely applied to the skin, an accident favored by a hairy skin. The cracked-pot sound may

also be produced in the normal chest by percussing it sharply while the patient is in the act of speaking or crying out, the narrow glottis affording the condition of a small opening. This may more readily be done under these conditions in children who have thin elastic chest walls.

The cracked-pot sound is produced in disease by percussing over a cavity which affords the condition named, viz., a somewhat superficial position, sufficiently yielding walls and communicating by a small opening with a bronchial tube and thence with the outside air. It is the most infallible sign of a cavity known. In producing it, the mouth of the patient is kept open and a sudden forcible blow of the plexor given. Often it cannot be heard unless the ear is attentively turned near the chest to catch the sound. The same conditions exist in a pneumothorax, with a thoracic fistula into the lung, and under these circumstances a cracked-pot sound may be produced.

AUSCULTATION.

Auscultation is the act of listening to sounds, more particularly those produced in the chest in the act of breathing or in the course of the heart's action, or in the blood-vessels, or to these sounds as modified by disease. In so doing the ear is applied either directly to the chest or through the intermediation of an instrument known as a stethoscope. According as this instrument is employed or not, the auscultation is **mediate** or

immediate. Both have their advantages. When it is desired to isolate or circumscribe a sound, especially in the study of the heart, the stethoscope helps us greatly, while in the study of more diffuse sounds, as many of those produced in the lungs, the direct application of the ear to the chest is generally to be preferred. The stethoscope becomes also desirable in the examination of patients not especially clean. In inexperienced hands, also, the patient is rendered uncomfortable by undue pressure with the head on the instrument.

The stethoscope was invented and used by Laennec, of Paris, in 1816, in its single shape. The binaural instrument was devised by Cammann, of New York city, in 1840. There can be no doubt that, with the latter, sounds are more loudly heard. On the other hand, all noises, as that of the rubbing of linen or clothing, are so much exaggerated that the beginner is often confused. The double instrument is becoming more popular of late, but preference depends on training. A man who has been brought up to use the double stethoscope soon grows to prefer it, while he who is trained to the single instrument would not have the double. When either form of the instrument is used, better results are obtained when the chest-end is applied directly to the bare skin, whereas in immediate auscultation it is desirable that there should be a thin, soft towel, or some thin garment, interposed between the ear and the skin. The ear or stethoscope should also be applied closely to the chest-wall so as to become a part of it or continuous with it; and yet, as stated, the stethoscope may be

applied too strongly, so as to give pain to the patient. Successful auscultation requires that the attention should be closely concentrated on the matter in hand.

The single stethoscope is made of wood or metal. That originally made by Hawksley, of London, out of

FIG. 8.

Hawksley's Stethoscope.

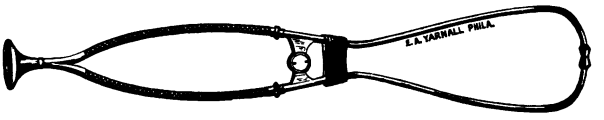
FIG. 9.

Robertson's New Stethoscope.

gun-metal, provided with a detachable ear-piece, shown in figure 8, is the most convenient and neatest. The double instrument, figure 10 in the text is partly metal and partly rubber tubing. The very simple instrument

of Sansom, of plain rubber tubing and a metallic tube end is much more conveniently carried. It is especially convenient when the patient is inaccessibly placed in

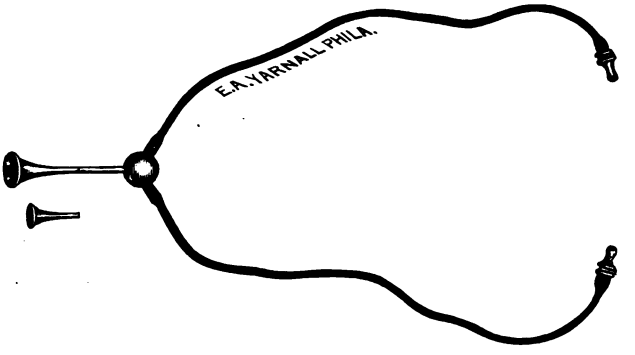
FIG. 10.



Simple Form of Double Stethoscope.

relation to the examiner, an advantage possessed in various degrees by all binaural stethoscopes over the single

FIG. 11.



Sansom's Double Stethoscope.

instrument. In selecting a Sansom's stethoscope, care should be taken to secure an ear-piece which fits the ear properly. Fig. 9 represents a new stethoscope devised

by Mr. W. E. Robertson, student of medicine, and made by E. A. Yarnall Co., in which the ear-piece is flexible rubber, which permits it to be closely applied to the inequalities of the ear, thus securing greater efficiency and greater comfort. The chest-piece has a soft rubber end secured to the metallic cone, which is at once more closely adherent to the part auscultated, and is also more comfortable to the patient against whom it is pressed.

AUSCULTATION OF THE NORMAL LUNG.

The breathing sounds in health are separable into two distinct orders: first, the **vesicular breathing** or **respiratory murmur**; second, **bronchial breathing.** Both are normal sounds, constantly produced in the act of breathing, but in certain parts of the chest one is produced more or less to the exclusion of the other. Thus the vesicular breathing is heard in its most typical character under the left clavicle, where it is best studied by immediate auscultation.

Bronchial respiration is the easier of description. It is blowing or tubal in quality, both in inspiration and expiration, and the two parts are nearly equal in length, the expiratory being often slightly the longer. It is heard in its purest form over the larynx and trachea, but also quite pronouncedly between the scapulæ at the root of the lungs, where, however, it is more or less admixed with vesicular breathing. The pitch is high in both in- and out-breathing, and somewhat higher in the latter.

Vesicular breathing is the sound produced by the movement of the air in the smallest bronchial tubes and air vesicles. It is also divided into two portions—the inspiratory and expiratory, the in- and out-murmur, the former being much the longer. Perhaps no language can give a correct notion of the vesicular murmur, but it is a soft, low-pitched sound, said to resemble the sighing of a gentle breeze through the leaves of a tree. It is the sound of the movement of the air in the finest bronchial tubes and air vesicles. As stated, when typical, the inspiratory murmur is much longer than the expiratory. The ratio is, however, not fixed. The expiration may be one-fourth as long, or it may be a mere whiff, as it were. It represents the recoil of the air vesicles and the backward movement of the air. The precise mechanism of the productions of the sound in question will be left to the physiologist, the present purpose being to consider the sound and its modifications in disease.

The vesicular murmur is not everywhere the same, even in health. As a rule it is loudest, most intense, below the left clavicle, and, assuming it to be typical in this situation, is nearest maintained in the axillæ and below the scapulæ. Under the right clavicle the slightest rise in pitch and a distinct prolongation of the expiratory portion is often noted, and to be remembered as of great importance in diagnosis, in doubtful cases. This is usually ascribed to an admixture of the bronchial element due to the larger size of the right bronchus, and of its branches sent up towards the right

clavicle. Over the scapular regions posteriorly the vesicular murmur is less intense, because of the thickness of the bones and muscles, but the same difference between the two sides may often be noted in the supraspinous fossae as below the clavicle in front. For the same reason it is less intense in the mammary regions, and in all fat and muscular persons as compared with the thin and emaciated. Between the angles of the scapulæ still more of the bronchial element is added than below the right clavicle, and the sound is decidedly more blowing and the expiration longer. It is to be remembered that both vesicular and bronchial breathing are being constantly produced in the lungs, but that in certain situations one overshadows the other, partly because it is being produced in greater degree immediately under the point where the ear is applied, and partly because the normal lung is a poor conductor of sounds.

MODIFICATIONS IN NORMAL BREATHING SOUNDS THE RESULT OF DISEASE.

Changes in the Vesicular Murmur.—The vesicular murmur is modified by diseased states as follows:—

1. It is jerking or interrupted.
2. It is increased in intensity or loudness.
3. It is diminished in intensity, more indistinct.
4. It is altogether absent.
5. It is commingled with bronchial breathing, by which it is rendered harsh and its rhythm altered.
6. It is substituted by bronchial breathing.

1. Interrupted or jerking breathing is the least important of the alterations in the vesicular murmur, being generally of no significance whatever. Such is its value in persons who are nervous or slightly alarmed during examination. The interruption affects most frequently the inspiratory act, but it may occur in either or both, and the act may be broken into two or three parts. More serious is its cause when it occurs in connection with severe pleurisy or pleurodynia, where the pain of the act of breathing causes the latter to be interrupted. It has here, however, no more significance than in nervousness. Finally it may be present in incipient tuberculosis or emphysema, but even here its diagnostic value is merely confirmatory, and that only when it persists.

2. Vesicular breathing is increased in intensity by any cause which compels the lung or a part of it to assume increased function. This happens in one lung or a part when the other or the remainder is deprived of its use by compression or destruction. In this change both the inspiratory and expiratory factors are proportionally increased in loudness and in length, the accentuation of increase being in the inspiratory sound rather than with the expiratory. Its pitch is unaltered. From the resemblance of this exaggerated breathing, as it is also called, to the normal breathing in children it is often called **puerile** breathing.

3. The vesicular murmur is diminished in intensity by various causes. Such feebleness affects the inspiratory murmur rather more than the expiratory, so that the

latter may be relatively prolonged, but it is, at the same time, even feebler than in health. Such diminution may be due to feebleness in the inspiratory act from debility, or to obstruction in the bronchus leading to the ausculted area; or to a loss of elasticity in the air vesicles, as in emphysema of the lungs or the very early stage of tubercular deposit. More commonly in actual practice, it is due to the interposition of a liquid or a solid medium between the lungs and the ear, such as a pleuritic effusion or the plastic exudation of a pleurisy. Or it is due to the filling up of the air vesicles by an exudate as in pneumonia, or tubercular infiltration in phthisis. More frequently it is obliterated by these causes.

4. The vesicular murmur is altogether removed by the higher degrees of the last named conditions, viz., pleuritic effusion, pneumonic and tubercular infiltrations.

5. The vesicular murmur is altered by the addition of a bronchial element, the first effect of which is to lengthen the expiratory factor of the breathing sound, to alter, in a word, its rhythm. Coincidently with, or immediately succeeding upon this, is a roughening of both inspiration and expiration, at first slight and then positive. As long as this degree is maintained there is still a vesicular factor in the breathing, whence it was named by Flint **broncho-vesicular breathing.** Expressive terms are also harsh respiration, rude respiration or rough respiration. Such modifications of normal breathing are brought about by an infiltration of a cer-

tain number of air vesicles with solid material, while others still maintain their function. The effect of this is also to improve the conducting power of the portion of the lung involved, so that it becomes a better conductor of the bronchial sounds elsewhere produced, which are thus brought to the ear. It means, therefore, that a certain small degree of consolidation has taken place.

How shall we distinguish between puerile breathing and broncho-vesicular breathing, a most important requirement, since they indicate opposite conditions? Yet there is a certain similarity between them which inexperienced observers may mistake for identity, and which even an experienced man may sometimes have occasion to dwell on before deciding. Both are louder and rougher as to inspiration, but vastly different is the manner in which expiration is influenced. In puerile breathing it may be slightly longer and more distinct than in health, but it maintains its ratio to the length of the inspiratory murmur. Not so is it with the rude inspiration. Here the expiratory sound is roughened and prolonged out of all proportion to the inspiratory. And in catching slight degrees of difference the attention must be concentrated on the expiratory murmur. If it is greatly prolonged in proportion to the inspiratory, so as to nearly or quite equal it, and at the same time harsher than in health, not simply louder, then we have broncho-vesicular breathing and the conditions which produce it. And if to this is added a slight rise

of pitch on percussion, a slight dullness, the condition is confirmed. Sometimes, however, these conditions do not go entirely *pari passu*. Then we must wait and watch. We must not forget, too, the physiological differences on the two sides, that there is the slightest higher pitch on the right in both percussion note and breathing sound, and that the expiratory murmur is slightly more distinct on the right. It must be remembered, too, that in simple feebleness of the respiratory vesicular murmur the expiratory element is less affected in its duration, but that here both inspiratory and expiratory sounds are less loud rather than more loud.

6. Finally, the vesicular murmur may be altogether substituted by bronchial breathing. This means that a considerable area of lung has become obliterated as to its vesicular structure, and in this change has also become an excellent conductor of the distant normal bronchial breathing, which is heard with a blowing tubal quality as though produced directly under the ear. Again, it is to be remembered, that there is no more bronchial breathing produced under these circumstances than there was before the consolidation took place. It is simply that the vesicular murmur has altogether vanished, for the reason named, and therefore cannot longer mask the bronchial breathing, while the latter also is better conducted to the ear. Acute croupous pneumonia furnishes the most characteristic bronchial breathing. Between this and broncho-vesicular breathing there is every degree depending upon the degree of destruction of vesicular tissue and the extent of consolidation. When the

consolidation is very intense the bronchial breathing is rendered more intense, more metallic even than the tracheal breathing sound, which may be regarded as the type of bronchial breathing.

Changes in Bronchial Breathing.—The more usual modifications of bronchial breathing are **cavernous** breathing and **amphoric** breathing.

1. **Cavernous Breathing.**—The beginner will not be discouraged at any difficulty he may have in distinguishing between bronchial breathing and cavernous breathing when he learns that at the present day the German clinicians do not attempt to distinguish between them. English and American observers have, however, usually separated them; both Flint and DaCosta, for example, say that the sign is more likely to be confounded with the normal vesicular murmur than with bronchial breathing, differing, says Flint,* from the former only in the absence in inspiratory sound of the vesicular quality.

In the first place the cavernous breathing is represented as more hollow in character, if this can be conceived, less tubal and therefore of lower pitch than bronchial breathing. The expiration is also commonly lower pitched than the inspiration, reversing, in this respect, the bronchial breathing, although this is not constant enough to be made a rule of difference.

The conditions of its production are a cavity with

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* "Manual of Auscultation and Percussion," 5th Ed., Phila., 1890, p. 107.

yielding and resilient walls, by the collapse of which the air can be forced out, since the sound depends upon the entrance and exit of air. It is also often associated with gurgling, or may alternate with it. It may disappear to reappear after copious expectoration. Cavities at the apex of the lung in tubercular consumption are the most common causes, but whatever produces an excavation of the kind may cause it. A dilated bronchus, an abscess and even gangrene of the lung may be such a cause.

2. **Amphoric Breathing.**—Amphoric breathing is more easily recognized from its ringing metallic character, like that of the amphoric percussion note, resembling also the sound produced by blowing upon the mouth of a bottle. It is produced by the same conditions, a cavity with firm walls. It is likewise a blowing sound, of high or low pitch, inspiratory or expiratory, or both. Clinically its presence most frequently means pneumothorax, but a phthisical cavity may furnish the same conditions. Every case of pneumothorax does not, however, produce it, since there must be a perforation of the pleura above the level of the fluid and free communication with a bronchial tube.

There are other modifications of bronchial breathing more or less accidental and therefore of less importance. Thus it sometimes happens that either the inspiratory or the expiratory portion is absent, when it may be still recognized by the pitch and quality of the portion remaining cavernous. Again we may have a vesicular inspiration with a cavernous expiration, or there may

be an admixture of cavernous and bronchial breathing, brought about by a combination of conditions which need not be mentioned here. Another variety of modification is the **Seitz-metamorphosing respiration**, in which the inspiratory sound is heard for about one-third of its time as harsh tubal and the remainder of ordinary blowing, cavernous, or amphoric quality. It is caused by air entering a cavity through a narrow opening.

AUSCULTATION OF THE NORMAL VOICE.

Normal Vocal Resonance.—When the ear is applied below the clavicle of a person speaking, a confused monotonous humming sound is produced, of slight intensity, and low pitch. In the aged it is apt to be tremulous or somewhat bleating. This is normal vocal resonance. It varies, however, in intensity and pitch in different persons, being almost inaudible in some. It depends also somewhat upon the manner in which the person speaks and the words he utters. It is increased not so much by loud speaking as speaking "from the chest." It is better noted also if the patient counts "one, two, three," or speaks the word "ninety-nine." It is also feebler in women than in men. It is accompanied by a fremitus, which is the same as that described under palpation. It is a tactile fremitus in which the ear is the touching part instead of the palm of the hand.

Vocal resonance varies in different parts of the chest, being more marked where the walls are thin. Hence

below the clavicles it is relatively loud, and more so below the right, just as is tactile fremitus, an important fact to be remembered in diagnosis, as well that everywhere on the right side it may be more marked. Towards the sternal portion of the clavicular region it is louder, the tracheal voice influencing it. Below the clavicles it diminishes with the greater thickness of the chest walls of the mammary region, is again more marked in the axillæ, less intense over the scapulæ and louder below them. Between the scapulæ it is also intense.

The **whispering voice** also requires some allusion. It being borne in mind that whispering in most persons is an act of expiration, if the ear is applied to a thin-walled portion of the chest, as below the clavicle, and the patient asked to count in a whisper, there is heard a feeble low-pitched blowing sound, unaccompanied by fremitus, with a pitch and quality the same as those of the expiratory vesicular sound in breathing. All that has been said of vocal resonance, as to its audibleness and the degree thereof in different persons and on the different parts of the chest, is true of the "normal bronchial whisper," as it is called by Flint, because "the conduction of the sound produced by the whispered voice must be chiefly by the air contained in the bronchial tubes."

Normal Bronchophony.—When the stethoscope is placed over the thyroid cartilage of the larynx of a person speaking, a much louder resounding sound is heard directly under the ear, accompanied also by a thrill or fremitus conveyed to the ear. But it is

still confused and no articulate words are heard. It corresponds to bronchial respiration as normal vocal resonance accords with vesicular breathing.

If the person thus ausculted over the larynx or trachea whispers instead of speaks audibly, a high-pitch tubal sound accompanied by fremitus is heard. It is, in fact, the expiratory breathing sound, as heard in these air tubes, interrupted by the act of speech.

Abnormal modifications of the ausculted voice. The correspondence of vocal resonance and normal bronchophony with normal vesicular breathing and normal bronchial breathing has been referred to. The same relation exists in pathological conditions. Thus any increase in the intensity of the normal vocal resonance implies a corresponding condensation of lung tissue, culminating in typical bronchophony when the consolidation is complete, just as the normal vesicular breathing passing through broncho-vesicular terminates in bronchial breathing. *Pari passu* with increased vocal resonance and broncho-vesicular breathing goes increased bronchial whisper, the usual rule of health, of slightly greater intensity on the left, a higher pitch on the right being remembered.

Pectoriloquy.—In addition there are certain special modifications of the normal vocal resonance corresponding more or less to certain morbid states. Thus there is the cavernous voice or pectoriloquy, in which articulate speech is heard as though coming directly from the chest into the ear. While this is sometimes the sign of

a cavity it is not always so, the voice being similarly transmitted by solidified lung. Whispering pectoriloquy is a much more reliable sign of a cavity.

Amphoric voice is ringing and metallic, like the other amphoric sounds, and like them indicates the same conditions—a large cavity with firm walls.

Ægophony is another very distinctive modification of the normal voice when ausculted. It is admirably likened to the bleating of a goat, and is produced during speech when there is a thin layer of liquid between the chest wall and the lung, in pleuritic effusions, or when there is liquid in the chest cavity from other causes.

Diminished Vocal Resonance.—Finally, speech sounds may be diminished in intensity by the same causes which diminish the tactile fremitus: pleuritic effusions, pleuritic thickening, compression of the lung by fluid or air, and by over-distention of the lung.

NEW OR ADVENTITIOUS SOUNDS.

These sounds are not a modification of preëxisting sounds, but something altogether new or additional. They include **râles** or **rhonchi**, the **friction sound**, and **metallic tinkling**.

Râles are new sounds produced in the trachea, bronchial tubes or in cavities, concurrent with the movement of air inwards or outwards in the act of breathing. They are the direct result of some partial obstruction to the onward movement of the air, for the most part within the tube, but the narrowing may also be the result of extra-tubal pressure. They are divided into

moist or dry râles according as the obstructing substance is liquid or the reverse. Both are influenced by coughing and may often be completely removed, for the time being, by this act. When not thus influenced by coughing they are probably due to pressure from without.

Dry râles are due to the vibration produced in thickened adherent mucus or the swollen mucous membrane of the bronchi, by air moving over them. Sounds produced in the tubes of large lumen, like the trachea, are musical, low-pitched, and are called **sonorous** râles. Those produced in the small tubes are high-pitched and hissing, and therefore called **sibilant** râles.

Moist râles are caused by the passage of air through liquid, which may be blood, mucus or serum. They are therefore of the nature of bubbling sounds and are spoken of as large and small bubbling sounds, according as the bubbles are large or small, and as large bubbles can only form in tubes of large size or cavities, they indicate these conditions, while the small râles indicate smaller tubes. The bubbling sounds are further subdivided, according to size, into gurgling, mucous, submucous, subcrepitant and crepitant râles, and crackling.

Gurgling is a term applied to the largest bubbling sounds, and is produced in cavities containing fluid. It is also known as the cavernous râle, and has sometimes a metallic character when it becomes associated with the other metallic physical signs already mentioned as characteristic of a cavity with firm walls.

The mucous râle is a bubbling sound smaller than the cavernous, but still of large size, produced in the trachea and larger bronchi. The death-rattle is a tracheal mucous râle. The **sub-mucous** râle is a smaller bubbling sound produced in tubes of smaller size, and the **sub-crepitant** in still smaller. The **crepitant** râle is formed in tubes of smaller size and in the air vesicles. It may be a true bubbling sound, or it may be due to the separation of agglutinated air vesicles by entering air. From its extreme importance in the diagnosis of pneumonia, although it occurs also in œdema of the lungs, it requires some further illustration. It is aptly compared to the crackling produced by throwing salt on the fire, or rolling the hair between the fingers alongside of the ear; also to the noise made by separating near the ear the moistened thumb and index finger. The first appears to me the best imitation. It is heard only in inspiration and is thus distinguished from the sub-crepitant râle, which is heard in expiration as well.

Crackling literally means the same as crepitation, and, in fact, the mechanism of the two signs is nearly the same. Both are inspiratory sounds, and both may be small bubbles. The main difference is really in the number of crackles which go to make up the râle, the crepitant consisting of several of these, while the crackling consists of but one, two, or three. "Crackling" is heard at the apices of the lungs, and the crepitant râle for the most part at the base. The interpretation of crackling is almost invariably tubercular consumption,

and it means that the tubercle is beginning to break down. Yet we may have pneumonia of the apex. What is known as "moist crackling" is a little larger râle than crackling, a pure bubbling sound produced in the smallest bronchial tubes, and is really a sub-crepitation.

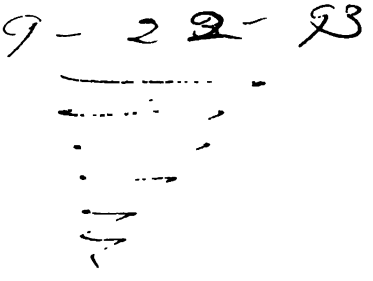
The **friction sound** is a noise produced by the rubbing of two slightly roughened serous surfaces upon each other. The pulmonary and costal pleuræ and the cardiac and pericardiac serous membranes move over each other smoothly and noiselessly in health, but let them be roughened in any way by an inflammatory exudate, an eruption of tubercles or other morbid growth, and at once the friction sound is produced. In its simplest and most frequent form, representing the first stage of pleurisy, it also resembles somewhat the crepitant râle, and it is sometimes not easy to distinguish from it. In addition, however, to being more superficial in situation, the friction sound is not influenced by coughing, while the crepitant râle is. The friction sound is heard more loudly if the stethoscope is pressed closely to the chest-wall and is localized, while the crepitant râle is heard over a large area of lung. It is also often a to-and-fro sound, being heard with expiration as well as with inspiration, while the crepitant râle is confined to the latter. The friction sound disappears with pleuritic or pericardial effusion, to return for a time with the subsidence of the effusion.

In addition to its typical crepitant-like character, as heard in pleurisy, the friction sound assumes also at

times greater roughness, which is more conspicuous in pericardial friction. Where organization has taken place in an exudate there is sometimes a leather-like creaking produced under the same circumstances as the friction sound, and it is regarded as a friction sound. It is sometimes so loud as to be heard by the patient himself, and may also be recognized by palpation. Pleural friction may be found anywhere in the chest but is more frequent in the sides.

Metallic tinkling is the last of the adventitious sounds to be considered. It is another one of the amphoric sounds, requiring a space with firm tense walls as its condition. A pneumothorax will furnish such condition, as also do certain pulmonary cavities. Under these circumstances a drop of liquid falling into such a space will produce metallic tinkling. This sometimes happens in a pneumothorax when a drop of secretion will sometimes fall from a bronchial tube into a cavity.

Allied to the metallic tinkling is the Hippocratic succussion, produced in pyo-pneumothorax and very rarely in a cavity, when the patient is shaken.



PHYSICAL SIGNS OF ABNORMAL STATES, OR DISEASES OF THE LUNGS.

ACUTE BRONCHITIS.

Acute bronchitis of the larger tubes is essentially a symmetrical disease, the bronchi of both lungs being generally more or less equally invaded. There may be absolutely no physical signs, inspection, palpation, percussion, and auscultation being alike negative. In other cases inspection may discover increased frequency of respiratory movement, and possibly increased frequency in the apex beat if there be fever. Palpation may appreciate a rhonchal fremitus if there be sufficient narrowing of the breathing tubes. It may be found anywhere or on either side and may be very transient. Percussion continues invariably clear so long as the bronchitis is uncomplicated.

Auscultation furnishes the most distinctive and constant physical sign, the presence of dry râles, the sonorous and sibilant, which may invade either or both lungs, and may also be transient. To these may be added harshness of breath sounds. In the resolution of bronchitis, bubbling râles may substitute the sonorous and sibilant, in consequence of the presence of secretion.

Capillary bronchitis involves the finer and finest tubules, into which it generally extends from the larger. The frequent breathing is more evident and constant; so the frequent heart beat with fever. Rhonchus may be felt, and there may be slight impairment of reson-

ance in the affected area. Auscultation gives constant results in the shape, first, of dry râles of the finest kind, followed very soon by small bubbling râles, submucous and subcrepitant, but dry râles are often absent. These signs are most frequent in the bases of the lungs posteriorly, but may extend all over.

CHRONIC BRONCHITIS.

Physical signs more constantly attend chronic bronchitis, yet they afford no unchanging picture. The frequently associated complication of emphysema of the lungs may be the cause of a diminished excursion of respiratory motion, to palpation a diminution of the normal vocal fremitus, and to percussion a hyper-resonance, unless in the vicinity of a superficial dilated bronchus filled with secretion, where there may be impairment of resonance. If such a dilated bronchus be emptied of its contents by expectoration, even the percussion signs of a cavity may be present, but in the middle or lower part of a lung instead of the apex.

Auscultation may even here be negative, but much more frequently exhibits an alternation or combination of harsh breathing and sonorous râles with moist râles of all sizes.

EMPHYSEMA OF THE LUNGS.

This condition, an over-distention and destruction of air vesicles with a like destruction of their covering of capillaries, is invariably the result of bronchitis and a

complication of it. It also affects both lungs at the same time, but involves different lungs and different parts of the same lung unequally.

The physical signs are more or less distinctive. Inspection discovers a rounded chest anteriorly and posteriorly, with bilateral enlargement, and wide intercostal spaces, the highest degree of which is known as the "barrel-shaped chest." But the emphysema may be so circumscribed as to produce local bulgings, by preference in the upper lobe of the right and lower lobe of the left lung. The excursion of expansion of the chest walls is diminished, while the scaleni and sterno-cleido-mastoid muscles stand out distinctly. The apex of the heart is displaced downwards and to the right, but it is often difficult to find, because covered up by the enlarged lung. Vocal fremitus is diminished, while palpation further discovers the natural resiliency substituted by increased resistance in the chest walls.

Percussion discovers resonance exaggerated in various degrees, sometimes almost tympanitic, the vesiculo-tympany of Flint. The cardiac dullness is extended to the right and downwards, partly from the displacement by the distended lungs, and partly from hypertrophy of the right ventricle. At the same time the cardiac area is more thoroughly covered by the lungs, and pretty strong percussion is often necessary to bring it out. The hepatic area of dullness is also lowered by reason of the encroachment of the lungs.

The distinctive auscultatory sign of the emphysematous area is the feeble inspiratory murmur, due to the

fact that the air vesicles are already distended with air and there is little further distention possible with the inspiratory act. The prolonged expiratory murmur is the result of the lost elasticity of the air vesicles, whence they recoil but slowly on their contents. Vocal resonance is diminished because of the diminished motion in the air columns. Feeble crackling is said to be sometimes heard. If bronchitis is present its sounds are associated and often obscure all else. The pulmonary second sound at the second left interspace is accentuated on account of the hypertrophy of the right ventricle, but the heart sounds are usually obscured by the extra covering of the lung. With dilatation of the right ventricle, which sooner or later succeeds, the accentuation disappears.

Interlobular emphysema, in which the connective tissue between the lobules is infiltrated with air as the result of rupture of air vesicles from violent acts of coughing, or of wounds of the lung, the physical signs except to inspection are the same as those of vesicular emphysema except that the crackling sound referred to is more common. The configuration of the chest in such cases is not usually altered.

SPASMODIC ASTHMA.

The physical signs of this peculiar neurosis reveal themselves to all the methods of physical diagnosis employed. Thus inspection discovers the most labored efforts in breathing, while the chest moves but slightly,

because the lungs cannot be inflated. The spaces above and below the clavicle and above the sternum, the intercostal spaces, and the pit of the stomach are drawn in, for the same cause,—that is the thoracic cavity not being filled from within, the external atmospheric pressure forces the yielding portions inward.

Rhonchal fremitus is recognized by palpation, while vocal fremitus, obscured by the rhonchus, is otherwise diminished by a frequently associated emphysema. Percussion is negative in uncomplicated asthma, but associated emphysema may produce abnormal resonance.

Auscultation furnishes the most striking and easiest recognized of the physical signs. All over the chest are heard sonorous and sibilant râles, inspiratory and expiratory, but more commonly the latter. In fact, for the most part, they do not require the ear to be placed close to the chest for recognition. The vesicular murmur, on the other hand, is inaudible.

It is to be remembered that chronic bronchitis, emphysema and asthma may also complicate each other, and render correspondingly complex the physical signs.

TUBERCULAR PHTHISIS OR CONSUMPTION.

Accepting the modern doctrine, that all phthisis is tubercular, there are three ways in which it invades the lungs.

1. As catarrhal or broncho-pneumonic phthisis.
2. As fibroid phthisis.
3. As miliary tuberculosis of the lungs.

Catarrhal Phthisis.—This, the most common form of consumption, presents two varieties, differing mainly in the rapidity of their course,—whence acute and chronic phthisis. The former is also known as phthisis florida or galloping consumption. Perhaps there should be added, as a distinctive feature of the latter, the diffuseness as well as the rapidity of the process.

Catarrhal phthisis resolves itself, with more or less definiteness, into three separate stages, of which the physical signs, commonly sought at the apices of the lungs, are also more or less distinctive.

1. The incipient stage or beginning deposit.
2. Stage of complete consolidation.
3. Stage of softening and cavity-formation.

1. Inspection, in the *incipient stage* is as often negative as not. A slight impairment of motion in the infra-clavicular space may be present, and more rarely a slight flattening of the same region. Page* mentions a prominence of the clavicle of the affected side as occurring. The body may continue well nourished or slightly emaciated, or the heart-beat in the normal position may be somewhat accelerated, while the respirations may also be slightly more frequent than is normal. Palpation discovers increased vocal fremitus in the same situation, although this may not always be recognizable in the first stage, while the physiological difference in favor of the right side is to be remembered. Percussion in this stage gives slightly higher pitch and impairment of resonance,

*"Physical Diagnosis," third edition, New York, 1891, p. 113.

which may be noted above, on, or below the clavicle. Dullness may sometimes be brought out by directing the patient to hold his mouth open during percussion, or to hold his breath at expiration.

On auscultation above or below the clavicle, we have the first evidence of abnormality in a prolongation of the expiratory murmur and harshness in the inspiratory sound — the broncho-vesicular breathing described. Theoretically this should be preceded by a diminished intensity in the inspiratory sound, owing to the interference of the newly-deposited tubercles with the movement of the air into them, but practically this is scarcely encountered, and if encountered is of such indistinctive significance as to be of little value. Increased vocal resonance is a constant accompaniment of these modifications in the normal breathing sounds, but both may be masked by a pleuritic thickening, and the physiological difference so often referred to must be remembered. Da Costa also calls attention to the fact that in a certain number of cases, at this stage, there is a blowing sound in the subclavian or pulmonary arteries, and that a murmur is sometimes present in the subclavian or pulmonary artery before any other physical sign is present. There may be concurrent with these signs, those of a bronchitis more or less acute.

2. In the *second stage* the changes discovered by inspection are more easily recognized. There is evident loss of flesh. The hectic flush is intermittingly present. Palpation may also discover an increased warmth of skin. The increased vocal fremitus should be plainly

recognized unless obscured by a thickened pleural membrane. Dullness is positive, as is also increased vocal resonance.

The bronchial factor in the breathing now becomes conspicuous, showing itself by the harshness and shortening of the inspiratory element, with the decidedly rough and blowing expiration; also a gradual diminution of the vesicular element, until the latter disappears entirely, and we have the typical bronchial breathing of extended areas of tubercular infiltration. This sign will now be found in the supra-spinous fossa as well. The high degree of vocal resonance, known as bronchophony, is now superadded as a valuable confirmation of complete consolidation. The auscultation signs of a concurrent bronchitis may also be present in this and the next stage.

3. In the *third stage* the information furnished by inspection is still more decided. Emaciation is extreme, and breathing and pulse rapid, the face often flushed. In this stage the superficial veins over the involved area may be prominent, partly from emaciation and partly from obstructed circulation. The vocal fremitus is still more marked, and even remains distinct over cavities, because of the consolidation around them, unless there be some obstruction to the entrance of air in the bronchus leading to the involved area. Rhonchal fremitus may be added if adventitious sounds are present. The skin is hot and dry, and sometimes harsh unless succeeding one of the sweats which characterize this stage, when it may be moist and clammy.

Dullness on percussion is always to be found in the third stage, but to it is constantly added some of the varieties of tympanitic note referred to, pure tympany, the 'cracked-pot' sound or amphoric resonance, due to cavities. These require sufficient size and superficial situation on the part of the cavity, and the other conditions described on pages 37, 38, 39 and 40. On the other hand, resonance may even be normal over a cavity some distance from the surface, especially if the percussion be lightly made.

In the third stage there may be continued the bronchial breathing of the second, but to it may be superadded the distinctive signs of a cavity, which may also supplant those of the bronchial breathing. These signs are cavernous breathing, cavernous voice, amphoric breathing and amphoric voice, pectoriloquy, either whispering or with the ordinary voice, the full import and condition of all of which have been described. To these are often added the large bubbling sounds known as gurgling, caused by the air bubbling through the fluid in a cavity. Metallic tinkling may be added to these phenomena, caused by the bursting of bubbles in a cavity with the amphoric conditions.

Fibroid Phthisis or Cirrhosis of the Lung.—Fibroid phthisis does not admit of the same sharp divisions into stages which characterize catarrhal phthisis. Frequently traceable in its initial symptoms to the inhalation of irritating substances, and much more chronic in its course even than the chronic form of catarrhal phthisis, the general clinical history is of great value in

distinguishing it from the latter. It is constantly associated in its beginning with pleurisy and it may be a sequel of it. The phenomena of retraction as noted by inspection are more marked and extensive, and are not confined to the apex of the lung. The heart is frequently dislocated and the apex correspondingly displaced, sometimes to an extreme degree. The intercostal spaces are often narrowed, the diaphragm may be drawn up. The modifications of vocal fremitus as revealed to palpation are not nearly as constant, being masked by the retraction and pleuritic complications, and may be absent. There is little or no elevation of temperature. Percussion is more constant in its phenomena, there being marked dullness and a wooden-like resistance. There is sometimes hypertrophy of the right ventricle due to the extra effort of the right heart to propel the blood through the obstructing lungs. Auscultation most frequently discovers bronchial breathing and exaggerated voice, but both of these may be lessened in intensity by thickened pleuræ.

A dilated bronchus is a frequent result furnishing the signs of a cavity, which may be in the middle or even at the base of the lung, and furnishes a copious expectoration characterized by a peculiar fetor.

To the signs of the fibroid state in a part of a lung are frequently added those of emphysema in the remainder or in the other lung.

The rarity with which the bacillus tuberculosis is found in the sputum in this condition is not regarded as

sufficient to exclude it from the category of tubercular diseases.

Acute **miliary tuberculosis** is not accompanied by any distinctive physical signs, and the diagnosis is made from the clinical and hereditary history rather than from such signs.

Not every case of tuberculosis of the lungs begins in the apex, nor even when it does thus begin are the physical signs always first discovered anteriorly. Examination of every case should therefore include the posterior portion of the lung, and especially the supra-spinous fossæ. Tuberculosis not very rarely succeeds upon a pneumonia as well as pleurisy, and especially a catarrhal pneumonia, when the signs first make their appearance in the area which has been made vulnerable by the previous state.

PNEUMONIA.

Acute croupous or lobar pneumonia, more common in the right lower lobe, presents three easy separate sets of physical signs corresponding to as many stages in the morbid process itself.

The first, or *stage of congestion*, in which the air vesicles are still open, is of short duration, terminating within the first twenty-four hours, and may therefore be overlooked. Inspection discovers the face flushed, increased frequency of respirations, with restricted move-

ment upon the involved side and exaggerated motion on the sound side. The patient lies by preference on the affected side because of the greater comfort it gives him. This posture not only diminishes the pain by hindering the motion of the affected side, but also lessens the dyspnœa by permitting unrestrained expansion of the side which is doing the work.

Palpation at first may even find diminished vocal fremitus on account of the relaxation of the air vesicles, but vocal fremitus becomes decidedly increased as the air vesicles fill up. The skin is hot and the pulse is frequent. Percussion gives but slight if any impairment of resonance. In fact, tympany or the vesiculo-tympany of Flint is frequently present in this stage as the result of the relaxation of the partially filled air vesicles, giving resonance by immediate relaxation. See p. 35.

In the very earliest stage the vesicular murmur may be feeble, but very soon comes the distinctive physical sign of pneumonia, the crepitant râle at the end of expiration, or if there be coincident pleurisy—pleuro-pneumonia—the closely simulating friction sound may be added. But all of these physical signs, even if carefully sought for, may be wanting if the pneumonia is deep-seated, as not infrequently happens, appearing as the surface is reached, or they may not be recognized at all if it remains central. Over the normal part of the lung, however, there is exaggerated vesicular breathing.

The second stage, or *stage of red hepatization* or solidification, lasting four or five days, furnishes unmistakable signs. All the signs pneumonia reveals to

inspection in the first stage are intensified in the second, and the breathing is markedly abdominal. To palpation, vocal fremitus is now intense, the skin is hot and dry, and the pulse continues frequent.

Percussion gives absolute flatness over the solidified area, with high pitch and short duration, except in those very rare instances alluded to on p. 39, where the extreme consolidation throws the column of air in the trachea and bronchi into vibration, producing tympany. This explanation is perhaps the only one when it occurs in the upper lobe. In a lower lobe, tympany may result in the same way, from the proximity of a dilated stomach. Over the adjacent normal areas, also, resonance is exaggerated in consequence of the supplemental action of these parts. There may even be here tympany or vesiculo-tympany due to the relaxation of the adjacent air-vesicles, an instance of resonance by mediate relaxation. Even cracked-pot sound may be produced by percussion over the solidified lung as the result of the sudden expulsion of air from a large bronchus leading to the solidified area.

Auscultation discovers high-pitched bronchial breathing over the solidified lung. Indeed, these are the circumstances which give the typical bronchial or tubal breathing. The air vesicles are obliterated, and the resulting excellent conducting medium brings the tracheo-bronchial blowing to the ear. The ausculted voice gives us typical bronchophony and occasionally even pectoriloquy as well as whispering bronchophony and pectoriloquy. The heart sounds are also heard with

great distinctness over the consolidated lung, owing to the improved conduction, while the sounds of a concurrent bronchitis are similarly intensified. A lingering crepitant râle may also be heard.

The third stage or *stage of grey hepatization* or resolution occupies six to ten days. It repeats largely, to inspection, palpation, and auscultation, the phenomena of the first. Resonance continues impaired for some time. The normal manner of breathing gradually returns, the temperature of the skin is noticeably less, the crepitant râle returns, technically known as the "crepitans redux," and is finally replaced by the normal vesicular breathing sound, by which time the dullness has disappeared.

Croupous pneumonia may rarely terminate in abscess or gangrene, when the signs of the second stage continue, the temperature does not fall, in a word the crisis does not occur. The signs of a cavity which might naturally be expected are rarely present, and it is rather by the general symptoms, the failure to recover, the continued high temperature, the expectoration of pus, and, in the case of gangrene, the intensely disagreeable odor, that informs us of the issue. These issues probably represent on a large scale what takes place in every instance in minute areas in the third stage of all pneumonias which terminate favorably. The occasional termination in tubercular phthisis exhibits a similar arrest of the resolving process in the second stage, and

the phenomena of the catarrhal or fibroid phthisis supervene.

The obscuring effect of a thickened pleura upon all of these signs is to be remembered, and too much stress cannot be laid upon the fact that we may have a central deep-seated pneumonia which may give no physical signs, also that in old persons the physical signs of a pneumonia are very apt to be delayed from one to three days.

Catarrhal or Lobular Pneumonia or Broncho-Pneumonia.—The physical signs of this form of pneumonia are not nearly so distinctive as those of croupous. A circumscribed affection involving a few lobules, the physical signs are necessarily more obscure. Occurring most frequently in the course of a bronchitis in children and in old persons, as well as *de novo* in the former, the physician should be on the watch for it under these circumstances. It also occurs in adults, though more rarely, especially in those suffering from tuberculosis, as the result of insufflation of broken down tubercular matter, which produces by inoculation and irritation a tubercular broncho-pneumonia. When superadded to a bronchitis under any of these conditions, there ensues increase of fever, embarrassed breathing and associated increased inspiratory effort. Palpation should discover increased vocal fremitus if the area involved be sufficiently large, percussion should reveal dullness, with possible increased vocal resonance and tympanicity of adjacent supplementally acting areas. Auscultation will

also discover in the inflamed area the crepitant râle, the bronchial breathing and bronchophony, in addition to the physical signs of the concurrent bronchitis.

Embolic Pneumonia and **Hemorrhagic Infarct.—Pulmonary Apoplexy.**—The effect of the lodgment of an embolus from any source in a branch of the pulmonary artery is to produce an extravasation of blood in the conical area formerly supplied by the vessel. Such an extravasation is called a hemorrhagic infarct. It is in fact a circumscribed apoplexy, but the term apoplexy of the lung is better retained for such extravasations of blood, circumscribed or diffuse, as are due to rupture of branches of the pulmonary artery from other causes than embolism. Such is over-distention of blood-vessels in valvular disease of the heart, disease of the blood-vessel wall, or traumatism.

Small infarcts of the lungs may give rise to no symptoms whatever. When large enough they cause sudden embarrassed breathing, rusty expectoration and circumscribed dullness, all of which increase with the size of the infarcted areas. Palpation reveals increased vocal fremitus, and auscultation crepitant and sub-crepitant râles, bronchial breathing and bronchophony. These are the signs of a croupous pneumonia which is indeed present, the consequence of the infarct which acts as an irritant. The circumscribed area covered by these signs would exclude an ordinary croupous lobar pneumonia, while the absence of fever, the suddenness of onset and the presence of cardiac disease aid in the diagnosis.

Similar symptoms may be caused by massive hemorrhage of the lungs or pulmonary apoplexy, caused by the rupture of a large branch of the pulmonary artery whose wall is weakened by tuberculous infiltration or the engorgement due to valvular heart disease. Such a vessel may suffer a further strain in consequence of some transitory congestion, and rupture occurs. A great mass of blood is poured out, which, besides entering the bronchial tubes and producing hæmoptysis and mucous râles, also infiltrates the lungs, coagulates and produces consolidation. If the patient lives, the blood in the bronchi may be insufflated into the vessels and there act as an irritant, producing intense inflammation followed by gangrene or abscess.

Pulmonary œdema furnishes many of the signs of the first stage of croupous pneumonia, and is accompanied by a frothy pinkish expectoration; but the absence of fever, and the presence of dropsy elsewhere, or its causes, account for the condition.

Collapse of the Lung.—In the course of a capillary bronchitis there sometimes occurs a collapse of a portion of the lung, owing to a valvular plugging of a bronchus, as the result of which air may pass out during expiration but cannot enter with inspiration, or it may occur as the result of a want of strength to fill the air-cells. The area of collapse often corresponds in size with that of lobular pneumonia.

When such collapse occurs there is sudden difficult breathing noticed on inspection, but palpation gives no information. Percussion discovers dullness, but it

is much less marked than in lobular pneumonia, while auscultation gives no bronchial breathing, or if it does, it is very feeble ; no bronchophony, but rather diminished intensity of breathing sounds and diminished voice. Collapse of the lung is apt to be symmetrical.

Cancer of the lung furnishes signs of consolidation very similar to those of the second stage of tubercular consumption. Flattening, dullness, blowing breathing, or bronchial breathing, all except elevation of temperature may be present, and it is the history of the case and special symptoms that determine the diagnosis rather than the physical signs. History of heredity, cancer elsewhere, cachexia, more constant and severe pain, are symptoms of importance in the diagnosis. A peculiar currant-jelly-like sputum is much mentioned as characteristic.

PLEURISY.

Acute pleurisy is also resolvable into three stages, each of which is characterized by physical signs more or less distinctive. They include a **dry stage**, a stage of **effusion** and a stage of **resolution** or **absorption**.

The first or dry stage is characterized anatomically by the presence of the so-called lymph or exudate on the pleural surfaces. During this is revealed to inspection a restrained expansion of the affected side, often thrown into jerks or catches because of the pain suffered in a continuous inspiration. The expansion on the opposite side, on the other hand, is full and unhampered. The

patient is apt to lie on the affected side. Very rarely does palpation recognize a fremitus corresponding to the friction of the two pleural surfaces. Percussion in this stage is negative, but auscultation recognizes the friction sound already described. It may be at a single spot in the infra-mammary or infra-axillary space, and hence be overlooked. At other times it may be noted over a considerable area.

The inflammatory process may stop here and resolution take place, or it may continue into the second or stage of effusion. The signs of this stage vary with the amount of liquid in the sac. With a small amount, the lungs are slightly floated up, and there may be no signs unless there be a vesiculo-tympany above the line of the fluid, a Skodaic resonance by mediate relaxation of the air vesicles.

The effusion, however, rarely remains so trifling, but commonly rises to the mid-chest. In the upright position of the patient, inspection discovers in a spare person shallowness and perhaps obliteration of the lower intercostal spaces. The motion of the chest wall is lessened both in the vertical and transverse directions.

To palpation vocal fremitus is diminished over the area of effusion, but may be increased in the lung above it. To percussion there is absolute flatness over the area of effusion, but the line of demarcation is not everywhere at the same level, being higher behind than in front. The late Dr. Calvin Ellis first called attention to an S-like curve in the line of demarcation which is said to be diagnostic. Very important in the

diagnosis is the fact that the fluid changes its level, and with it the line of dullness, when the position of the patient is changed. There is also an abnormal sense of resistance to the finger in percussing over the area of effusion. Above the effusion, especially anteriorly, there is again Skodaic resonance by mediate relaxation, and even sometimes a cracked-pot sound. Tympany may also be present, due to the proximity of a distended stomach.

To auscultation, the breathing sounds are inaudible or very feeble, as compared to the corresponding portion of the opposite side, but vocal resonance, though diminished, is still well heard where the collection of fluid is moderate. Above the line of dullness there is occasionally a friction sound, and close to the root of the lung bronchial breathing may be heard. This is, however, more apt to be the case when the effusion is larger and the lung is further compressed. Egophony is also sometimes heard.

When the effusion is larger, filling up two-thirds or three-fourths of the pleural sac, the effects described are increased, while new ones are added. Respiratory movement is still more hampered, the intercostal spaces are widened and even bulging, while fluctuation may sometimes be recognized in them. The heart is displaced by the accumulated fluid, and if it be in the left sac, the apex is often found far over to the right of the median line, and if on the right, the apex is pushed further to the left. Its sounds are not, however, altered further than to be heard more intensely in the situation

where they are not usually so heard, because sound is transmitted more readily through a single uniform medium than through two or more of different densities. On the opposite side, the breathing movements are supplementally increased. There is complete absence of vocal fremitus.

Percussion is absolutely flat all over the effusion, and Skodaic resonance is not now obtainable because the lung is too thoroughly compressed up into the apex of the sac. Resistance to pressure is marked. Bronchial breathing is, however, heard at the upper posterior of the lung, because the large tubes are still pervious to air, and the compressed lung intensifies the sound. Sometimes bronchial breathing is heard in more peripheral parts of the chest, probably conducted hither along a band of adhesion or along a rib. Elsewhere there is absence of breath-sounds. Vocal resonance and whispering voice are alike absent, or the former is very feeble. In certain situations, too, high up, where there is but a thin film between the chest-wall and the lung, there may be egophony, but this is more apt to be present as the fluid is being absorbed.

In the third stage, if resolution takes place with a gradual retrocession of the fluid and the reëxpansion of the lung, we have a return to normal physical signs. There may be, too, a **friction redux.** A considerable time is, however, required for absorption, and it is often many days before the normal breathing sounds are heard with their usual intensity or the natural fremitus is felt. Often resolution is not complete, and

there then remain the symptoms and sequelæ of a chronic pleurisy.

Chronic Pleurisy.—Its symptoms and sequelæ are not uniform. The simplest and most harmless expression is a thickened pleural membrane. In this there is no adhesion between the opposite pleural surfaces, and the motion of the lung is not interfered with. There is, however, a general interference with the conduction of sound, and all the normal physical signs, including vocal fremitus, vocal resonance, normal percussion sounds and normal breathing sounds are diminished in intensity. For the same reason many abnormal physical signs, as already more than once instanced, are also less plainly heard.

The harmful symptoms of chronic pleurisy are more frequently manifested in the results of delayed absorption of effusion, and in a change of its character from serous to purulent. The resulting accumulation of fluid in the pleural cavity is not always a continuation of acute disease. A chronic pleurisy may originate *de novo*, and often without the consciousness of the patient, although a careful analysis of the case will not fail to find symptoms of ill-health which are explained by the state of affairs ultimately found. Such pleurisies are known as **latent.** With the discovery of the effusion, which may depend more or less on the acumen of the physician, the latency disappears.

Such fluid furnishes the physical signs which have already been detailed on p. 80. Its further effects vary very much according as it is serum or pus. In either

event its speedy removal is desirable, because the longer it remains compressing the lung, the longer will the latter be in returning to its natural state. Hence, it is better done by aspiration than by the slower method of medication. If the fluid be serous, and if it has not been too long retained, the lung gradually resumes its normal state, and a thickened pleura is all that remains, with the physical signs referred to as associated with it. Not infrequently, however, the two pleural surfaces, costal and pulmonary, remain permanently agglutinated, and then, although the lung slowly resumes its natural function, there still remains some flattening over the lower part of the thorax.

If the liquid be pus, we have an **empyema**, and the consequences are much more serious. The occurrence of a chill and continued high temperature will suggest a purulent collection. Baccelli's test may be tried.*

Medical treatment almost never removes it, and aspiration is as invariably followed by reaccumulation. Hence, permanent measures, as the introduction of a drainage tube or exsection of a rib, must be used. Even here, if the drainage tube be inserted early, the lung may resume its natural office, and there may be no more permanent damage than the agglutination re-

* Baccelli, of Rome, in 1875, suggested a method of distinguishing purulent accumulations from serous. He found that the whispered voice was often audible over these serous accumulations, while it was inaudible over pus collections. Douglas Powell, Transactions of International Medical Congress, 1881, failed to confirm this observation.

ferred to, and subsequently a retracted thorax. More frequently, however, we have to do with a lung partly bound by adhesions into its new and unnatural position, while the pleural surface may be looked upon as an extensive ulcer. The restrained lung is unable to expand to refill its natural space, while the huge ulcer referred to must heal slowly with a resulting cicatrix. This cicatrix has the property of all cicatricial tissue. It must contract, and with this contraction drags with irresistible force whatever is attached to it, including the ribs and eventhe spinal column, which is sometimes drawn out of line. Thus there results distortion, in various degrees, of the shape of the thorax, associated with a shortness of breath which is permanent, but which may, nevertheless, grow less as time rolls on.

A result of empyema which remains to be alluded to is a circumscription of pus into two or more separate or communicating spaces, which may even be multiple. It is not always easy to recognize such a state of affairs. Most frequently it is ascertained by the attempt at removal by tapping, the withdrawal of a certain amount of fluid giving partial relief and leaving areas with physical signs unchanged. Da Costa gives us from Jaccoud * some points to assist towards such recognition. Given, in the area of dullness, a zone along which vocal vibrations are preserved, as from the spinal column towards the sternum, and a separation between two portions of

* Da Costa, op. citat., p. 366, from Bulletin de l'Académie de Médecine, 1879.

fluid probably exists along such line. Again, if voice and fremitus continue, though feebly, except in a zone of a few finger-breadth behind, and at the lower border of the chest, while no tympanitic sound can be elicited under the clavicle, it may be concluded that the effusion is multilocular. When diaphragmatic adhesions exist, the normal movements at the epigastrium and hypochondrium are reversed, and inspiration is accompanied by depression in the lower intercostal spaces instead of a filling out.

One other feature must be pointed out as associated with such collections, and that is pulsation sometimes communicated to them by the heart. Hence the term **pulsating empyema.** Such a one recently occurred to the writer. It was below the left clavicle, and so striking that he hesitated to puncture it lest it be a pulsating auricle or an aneurism. The knowledge that there was pus elsewhere in the pleural sac, the elevation of temperature and the absence of sound or murmur or thrill seemed to justify operation, and a large quantity of fetid pus was drawn through a communication made with a pus cavity lower down. The tumor and pulsation and fever disappeared and the patient, who was a girl, recovered.

PNEUMOTHORAX.

This comparatively frequent complication of tubercular consumption, commonly results from the rupture into the pleural sac of a cavity in the lung, an accident

usually brought about by a fit of coughing. This results in a rapid filling of the pleural cavity with air, which is soon followed by an effusion of liquid, generally purulent. The result is a distended air sac occupied to a certain height with liquid, compressing somewhat the lung and displacing the heart, while the physical conditions are those of a resounding cavity.

The effect on the physical signs is as follows: To inspection a bulging chest, a filling out of the intercostal spaces. The thoracic wall on the affected side diminishes its excursion of respiratory movement, or it appears at a standstill. Palpation discovers no vocal fremitus. Percussion furnishes over most of the half of the thorax involved, the most striking of the percussion notes, the ringing, amphoric resonance, which contrasts strongly with the absolute dullness due to the fluid below. To auscultation the breathing sounds are distant and feeble, the expiratory sound continuing short, but the voice is ringing, amphoric, and an unmistakable tinkling sound attends the dropping of fluid from the perforation into the fluid below. To a sudden shaking of the body there results a splashing sound similarly intensified by the reechoing to which it is subjected.

PHYSICAL EXAMINATION OF THE HEART.

Anatomical Relations of the Heart.—The actual boundaries of the heart in the chest cavity demand some notice. The base of the heart is held fast by the great vessels coming from it, but the remainder of the organ has a certain freedom of motion chiefly rotatory, but slightly also of elongation, limited only by the pericardial sac attached to the diaphragm and pleuræ. The heart lies upon the central tendon of the diaphragm. The auricles are nearly transversely placed, on a level with the third costal cartilages, both extending slightly beyond the corresponding borders of the sternum. The ventricles are obliquely placed, the right being in front and directly under the sternum, extending beyond both edges but more to the left. It is on a level below with the sixth cartilage. A much smaller portion of the left ventricle is turned to the front when the heart is *in situ*, and it is altogether within the line of the nipple, the apex corresponding to a point between the fifth and sixth cartilages and an inch and a-half below and within the nipple. The base of the heart corresponds behind with the fifth and sixth dorsal vertebræ, between which and it lie the aorta and œsophagus. The heart surrounded with its pericardial sac is covered very largely by the lungs, the right extending to the middle of the sternum, the left also to the middle as low as a line continuous with the lower edge of the fourth cartilage, along which it passes across the fourth interspace and the fifth

rib, the lung covering the whole of the left ventricle except the apex.

The Præcordium.—By the **præcordial region** or **præcordium** is meant that portion of the thorax covering the heart, and it may be said to be bounded above by a line drawn through the junction of the manubrium with the blade of the sternum, below by a line drawn along the upper edge of the sixth cartilage, and laterally by a vertical line drawn through the seat of the apex-beat, and another three-fourths of an inch to the right of the sternum. In this region inspection and palpation discovers the apex-beat between the fifth and sixth ribs and an inch and a-half below and within the nipple. In children it may be found an interspace higher, and in the aged and persons with long and narrow thoraxes it may be an interspace lower. Occasionally, in the second interspace to the left of the sternum in thin persons, a feeble impulse can be seen produced by the dilatation of the left auricle. The situation of the apex is slightly altered by changes of position or by distention of the stomach from any cause. The act of breathing, however, influences it most. With a deep breath the heart descends and is pushed inward by the inflated lung, and the impulse approaches the epigastrium. On a deep expiration it rises slightly, and while the breath is held remains higher. The apex-beat is rendered more distinct by exercise or emotion. This is still more the case in pathological states where there is enlargement. Emphysema of the lungs and effusion into the pericardial sac render

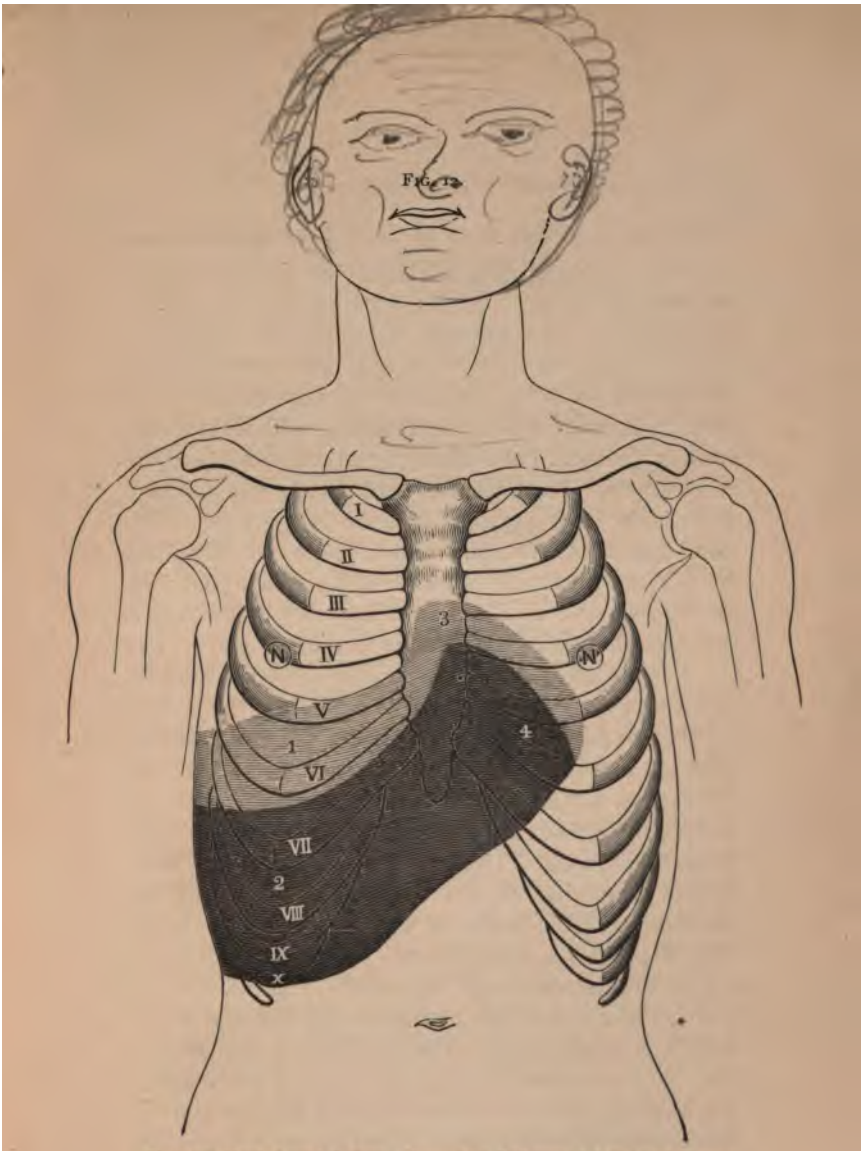
it more or less indistinct. Its position is also variously changed by morbid conditions, and a thrill or fremitus is sometimes communicated to the hand in valvular diseases.

Fremitus is also sometimes noticeable as the result of pericardial friction. The whole præcordial region is sometimes abnormally prominent in hypertrophy and pericardial effusions, especially in the young, while retraction due to adhesion is also seen. In the neighborhood of the præcordium, at the root of the neck, pulsations, arterial and venous, are noted, also epigastric pulsations, which will be explained under the head of the conditions that produce them.

PERCUSSION AND AUSCULTATION OF NORMAL HEART.

The **percussion boundaries** of the heart have been already mapped out on page 29, but it may not be amiss to review them at this point somewhat more in detail.

The Percussion Borders of the Heart.—To map out the percussion borders of the heart, we begin percussing on a horizontal line at the left edge of the sternum, at about the second interspace, proceeding downward by moderately strong percussion, only, until positive dullness is reached. This is usually found to be on the fourth costal cartilage, which is the upper border of the uncovered area of the heart, and where a line should be drawn. We then begin to percuss on a vertical line at the right edge of the sternum below the fourth rib, and proceed across the sternum until dull-



Showing Absolute and Relative Percussion Dullness of Liver and Heart.

ness is reached, which is in most cases towards the left edge of the sternum, and this is the right border of the absolute dullness of the heart, and here a vertical line is drawn. The situation of the apex is then found by palpation or by the stethoscope. Percussion is again commenced on an oblique line in the direction of a line from the junction of the fourth cartilage with the sternum towards the apex, but sufficiently beyond to be certain of clearness. Then parallel with such a line proceed downwards until positive dullness is reached. The lower border of the heart cannot be satisfactorily separated by percussion from the liver, but such a boundary can be obtained with sufficient accuracy by drawing a line from the apex perpendicular to the sternum. Thus the area of **absolute dullness** in adults will correspond to a rough triangle of which the base is 2½ to 3 inches, the perpendicular 2½ inches and the hypothenuse 3½ to 4 inches on a somewhat curved line.

The area of **relative dullness**, elicited by stronger percussion, extends a short distance in every direction except downward. The exact measure of this must depend somewhat on the delicacy of the ear of the examiner, and the mode in which he percusses, but it may be put down approximately as a finger's breadth, and on the left within the nipple line in adults.

In children, the area of the cardiac dullness is decidedly reduced on acount of the intense resonance of the child's thorax. In old age, on the other hand, the area of absolute cardiac dullness is increased on account of the shrinkage of the lungs. The upper

border of absolute dullness is at the fifth rib, and the apex may be in the sixth interspace.

The effect of a deep inspiration is materially to diminish the area of dullness, while that of expiration enlarges it. Pathologically the normal area is increased downwards to the left in hypertrophy of the left ventricle, downwards towards the epigastrium and to the right in hypertrophy of the right ventricle.

The **auscultation** of the **normal heart** is very simple. It consists in the recognition of the normal heart-sounds, known as first and second. Both sounds are audible over the whole præcordial region in health, but the **first sound**, characterized by its longer, booming character and lower pitch, is heard most loudly at the seat of the apex beat, where it is the louder of the two. The **second**, shorter, sharper, higher-pitched, and more snapping in character, is most intense at the base of the heart, on the sternum opposite the second interspace. Both sounds are heard at both situations, but each has its situation of greatest loudness. Hence, at the apex the rhythm may be said to be represented by the trochaic foot — ⏑, while at the base it is represented by the iambus ⏑ —. The two sounds have also been long compared to the word *lub-tub*, the first syllable corresponding to the first sound, and the second to the second part. While this word cannot be said to resemble the heart-sounds very closely, there seems to be no other that resembles it more.

As to the **mechanism** of the sounds, while that of the first is probably somewhat complex, including the

shutting down of the auricular ventricular valves, the apex beat, the rush of the blood through the aorta and pulmonary artery, and the noise of the muscular contraction, it is sufficient for clinical purposes to consider it produced, as it undoubtedly is for the most part, by the shutting down of the auriculo-ventricular valves, the mitral or bicuspid on the left side, and the tricuspid on the right. Both sets of valves shut down simultaneously, both contribute to the production of the sound, while the greater muscular power of the left side gives to it a distinct predominance. The second sound is of simpler mechanism, and is caused solely by the shutting down of the semilunar valves of the aorta and pulmonary artery with the recoil of the blood upon them. On account of the more powerful recoil in the aorta, the aortic is the predominating sound. We may, however, isolate the part of each set of valves by carrying the stethoscope to certain situations, and in diagnosis constant advantage is taken of this. Thus, in order to pick out the mitral part of the first sound, the stethoscope is placed at the seat of the apex beat, while the tricuspid factor is best heard at the left sternal border, between the fifth and sixth cartilages. So with the second sound, the aortic factor is best heard at the second interspace to the *right* edge of the sternum; and the cartilage just above this is known as the **aortic cartilage**, because this great vessel approaches next to the chest-wall in this situation. The pulmonary part of the sound, on the other hand, is heard at the *left* edge of the sternum at the second interspace, while the cartilage above this,

behind which ascends the pulmonary artery, is called the **pulmonary cartilage.** These points, and a circle

FIG. 13.

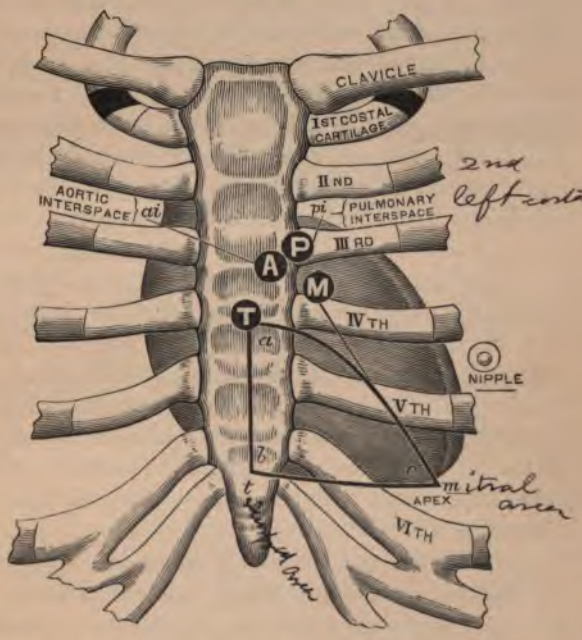


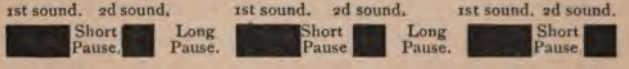
Diagram showing location of cardiac valves and points of maximum intensity connected with them. The triangle *a b c* is the area of superficial dullness.—*After Page.*

about an inch in diameter around them, are known as the mitral, tricuspid, aortic and pulmonary **areas.**

It is to be remembered, however, that these are not the precise seats of the valves themselves. These are all situated in wonderfully close proximity to each other —in fact a portion of each is contained within a space of less than half an inch square. The **mitral valve** is placed behind all the others, at a point corresponding to the left border of the sternum at the third interspace, vertically upwards across the attachment of the third costal cartilage. The **tricuspid valve** corresponds to a line drawn obliquely across the sternum from the third left interspace to the fifth costal cartilage of the opposite side. The **aortic valve** lies nearly horizontally behind a line joining the middle of the sternum and the end of the third left costal cartilage. The **pulmonary valve**, a little higher and to the left of the aorta, runs quite horizontally, corresponding to a line drawn along the upper border of the third left costal cartilage. The want of identity of the auditory valve area, or place where the sounds are best isolated, with the actual sites of the valves, is due to the fact that the sounds are best heard at points on the chest-walls nearest the cavity or channel in which vibrating blood is flowing.

The normal heart-sounds are heard less loudly over the normal areas during deep inspiration, when they are more completely covered by the fully expanded lungs, and the first sound is heard more loudly at a new point towards the median line to which the apex is pushed by the inflated lungs. On the other hand forced expiration increases the area over which the sounds are heard.

The **time** of the normal heart-sounds requires some further study because on a thorough understanding of this depends largely skill in diagnosis. The first sound begins with the systole of the ventricles and is coincident with the apex-beat, the second occurs in the diastole, immediately after the first with a short pause between. The second sound is succeeded by a longer pause occupied with the diastole of the ventricles during the latter part of which occurs the systole of the auricles, terminating the diastole of the ventricles. Thus if a revolution of the heart's sounds and pauses be represented by a dash and interspaces we will have the following:—



It is to be remembered that each one of these sounds is double, two systolic occurring at the ventricular orifices, and two diastolic at the aortic and pulmonary orifices. It may be further conceded that the first sound as heard at the base of the heart and the second sound as heard at the apex are simply conducted from the seat of their production, and that they are in no part produced at the situation where they are less loud.

ABNORMAL MODIFICATION OF HEART-SOUNDS.

It is not impossible, even in health, to have these paired sounds separated, and thus is produced what is known as **reduplications** of the heart-sounds, a phenomenon more common in diseases of the heart. Thus

as the effect of running there may result such an engorgement of the lesser circulation that as the result of high tension in the pulmonary artery, the pulmonary valve closes a little sooner than the aortic, and reduplication of the second sound occurs. In like manner the closure of the tricuspid valve may be retarded, the synchronism destroyed, and reduplication of the first sound thus produced. The first sound is reduplicated at the end of expiration and beginning of inspiration, the second at the end of inspiration and the beginning of expiration. The same and similar conditions operate to produce reduplication of the heart-sounds in disease.

The **intensity** of the heart-sounds is greater in persons with thin chest-walls, and under the influence of excitement. Abnormally the feverish state and general hypertrophy have the same effect, but the latter is more apt to influence the sound of the particular cavity which is hypertrophied. The heart-sounds are often heard with unusual distinctness at points distant from their normal areas because of consolidation of adjacent lung. Intensification or accentuation, as it is called, of the aortic or pulmonary element of the second sound is caused by whatever produces increased tension in the arterial or pulmonary circulations. Heart-sounds are also sometimes made ringing by their proximity to a cavity with firm walls or even a tensely distended stomach.

Abnormally, heart-sounds are rendered less intense by general and cardiac weakness, fatty degeneration of the myocardium, pericardial, and pleural effusions, and

emphysematous lungs which cover up the heart more completely.

Abnormal Heart-Sounds or Murmurs are modifications of the normal sounds, superadded to them or altogether substituting them. These are produced within the cavity of the heart, and are accordingly known as endocardial. In addition an altogether new sound is engendered external to the heart, and therefore called exocardial or pericardial. To this the term murmur is also applied, although the mechanism of its production is so widely different it does not seem to me desirable to perpetuate the practice.

The **endocardial sounds** or heart **murmurs** are sounds produced by an alteration in the conditions of normal blood currents either by structural changes in the heart or its valves, or in the composition of the blood.

The former are called **organic** murmurs, the latter **functional** or **accidental.*** Both are the result of vibrations or oscillations in the blood stream produced by the causes referred to, and not of a friction between the blood current and the narrowed orifices or inequalities on them. Hydraulic laws teach us that when a fluid passes through a tube the walls of which it wets, a thin film of fluid becomes attached to the inner wall over which the remainder of the fluid moves without friction. So it is with the cardiac cavity and its valves

*The term inorganic is sometimes applied to the functional murmurs, but this word has another meaning so definite, that of mineral, that it seems almost misleading to apply it in the sense referred to in the text.

over which the blood moves. Further, while a fluid is passing along a tube of uniform diameter at a moderate speed, no murmur results, whether the inner wall of the tube be smooth or rough. A murmur is only produced when the tube becomes suddenly narrower and then widens again, and the greater the narrowing the less speed of current required to produce the murmur. Thus the vibrations arise and thus the sound is produced.

In the case of functional murmurs which apparently occur without the intermediation of sudden narrowing, we must suppose such a change in the composition of the blood, either as to its density or viscidity, which permits it to be more readily thrown into vibration. In either event there is a derangement of that normal adaptation of the column of blood to the orifices and cavities through which it has to pass, which, under ordinary circumstances, permits the function of the heart to be performed noiselessly except so far as its normal sounds are concerned. In the case of the organic murmurs the alteration is produced by the various valvular defects to which the heart is subject, in that of the functional murmurs by the various anæmias which are principally associated with such murmurs.

ORGANIC MURMURS.

An organic murmur may be produced at any one of the four cardiac orifices, mitral, tricuspid, aortic or pulmonary. They are far more common at the mitral and aortic.

Murmurs are also classified as systolic and diastolic. **Systolic** murmurs occur during the systole of the ventricles, **diastolic** murmurs during their diastole, and these alternate with the apex beat. A diastolic murmur which immediately precedes the systole is called a **presystolic** murmur. Murmurs are further classified as direct and indirect. **Direct** murmurs are those which arise in the blood current as it is flowing in the normal direction; **indirect** are those which arise in a current flowing opposite to the natural direction. The order in which murmurs are considered is of little importance. Their great frequency seems a sufficient reason for taking up mitral murmurs first.

Mitral Murmurs.—*The mitral systolic or mitral indirect murmur.*—During the systole of the ventricles the auriculo-ventricular orifices in a perfect heart are closed in order to prevent the return of the blood to the auricles, while the aortic and pulmonary orifices are wide open to carry the blood into these great vessels, while the ear placed at the apex hears mainly the first sound. If, however, there be a defect in the mitral valve as the result of which it closes imperfectly, then, during the systole a stream of blood will flow backwards into the left auricle accompanied by a murmur. This is the mitral systolic murmur and it means **incompetency** or **insufficiency** of the valve and **regurgitation** of blood. The mitral systolic murmurs are almost invariably best heard in the mitral area at the apex, and are conducted into the left axilla and under the angle of the left scapula. Rarely, however, they

are heard just to the left of the pulmonary area, probably because the vibrations are conducted into the appendage of the auricle and are best heard where this approaches nearest the surface, namely, an inch and a-half to the left of the pulmonary area. This occurs more frequently, too, with functional murmurs.

Mitral diastolic and *presystolic murmurs, or mitral direct murmurs.*—During the diastole of the ventricles the aortic orifice is closed and the mitral orifice open, and the blood flows noiselessly into the left ventricle, the filling of which is finally completed by the systole of the auricle. If, however, the mitral orifice be narrowed from any cause, the blood column is thrown into vibration and a murmur results—a diastolic murmur. When, as sometimes happens, the narrowing or stenosis is not sufficient to cause a murmur throughout the entire diastole, but only when the additional momentum is given to the blood by the systole of the auricle, a murmur occurs only at this time—that is, just before the systole commences. It is then called presystolic. These murmurs mean, therefore, **mitral stenosis,** which is, however, generally associated with incompetency of the mitral valve. The diastolic murmur is, for the most part, soft, but the presystolic is rough, and is characterized by Flint as "bubbling," being compared by him to the vibration by the lips caused by blowing the breath through them. A presystolic thrill, felt at the apex of the heart, often accompanies the murmur. These murmurs are best heard in the mitral area, and are *not*, as a rule, *conducted* thence in any direction.

Aortic Murmurs.—*Aortic systolic or aortic direct murmur.*—During the systole of the ventricles in health, the aortic orifice is wide open, and the blood flows noiselessly through it. If any interference with the complete opening of the orifice, or roughness or inequalities exist, the stream of blood is thrown into vibration, and the aortic systolic murmur results, heard at the base of the heart. Such a murmur, therefore, means narrowing or **stenosis** of the **aortic orifice**. It is generally loud and harsh, sometimes musical, heard most loudly in the aortic area—second *right* interspace—but generally all over the chest. It is conducted into the great vessels of the neck with great intensity.

Aortic diastolic or aortic indirect murmur.—During diastole the aortic orifice should be closed and impermeable to blood. If, however, as the result of disease, perfect closure be impossible, a stream of blood will flow backwards into the left ventricle, accompanied by a murmur at the base, which is the aortic diastolic, and means always **insufficiency** or **incompetency** of the **aortic** valve. This murmur is generally soft, long and blowing, and varies more in the seat of its intensity than any other cardiac murmur. Generally loudest in the aortic area, but often louder than this over the mid-sternum, it is even well heard as low as the ensiform cartilage, or at the apex itself. It is also conducted into the great vessels of the neck, but likewise downwards along the sternum. It is accompanied by a powerful heaving impulse, and the characteristic trip-hammer or Corrigan pulse, characterized by its rapid rise

and sudden fall. It also occurs alone, but is frequently associated with the aortic systolic murmur, indicating stenosis as well as incompetency.

Right-sided Heart Murmurs.—The same conditions at the valve orifices on the right side of the heart produce similar murmurs, but they are very much rarer. Thus **tricuspid regurgitation** produces the tricuspid systolic murmur, and **tricuspid stenosis** produces the tricuspid diastolic murmur. These are heard in the tricuspid area at the lower part of the sternum, at its junction with the fifth and sixth cartilage. **Pulmonary stenosis** scarcely occurring, except congenitally, produces the pulmonary systolic murmur, and **pulmonary regurgitation,** the rarest of all, would produce a diastolic murmur. Both are heard in the pulmonary area at the second interspace, at the left edge of the sternum.

Impurity of Heart-Sounds.—In addition to the easily recognizable abnormal sounds described, there occur more or less marked modifications of the normal sounds due to slight defects of the valves, which render them less typical, whence the term impurity of heart-sound. They may be caused by slight thickenings or other changes which modify the normal closure of the valves, and are of uncertain significance. On the other hand, very decided alterations in the valves and orifices are sometimes found at the necropsy when no modifications of the normal sounds were detectable during life.

The Exocardial or Friction Sound.—The only true exocardial murmur is the **pericardial friction**

sound caused by rubbing of the two surfaces of the pericardium upon each other, in health a noiseless act like that of the pleural surfaces. When roughened, however, by disease a to-and-fro sound of varying loudness and harshness is heard. The most frequent cause is pericarditis, but any cause which roughens the two opposite surfaces, such as tubercular and other morbid growths, will produce a friction sound.

The friction sound sometimes resembles the intracardial murmur, but a little experience enables one to distinguish them. The friction sound is a superficial to-and-fro sound heard directly under the ear, commonly loud and rasping, never blowing, sometimes creaking. It is most loud over the middle of the heart, not synchronous with the normal heart-sounds and not conducted in the direction of the blood-current. It is often influenced by changes of position or by breathing. It may sometimes be felt by the hand placed over the heart. It is generally of short duration and disappears with the filling of the pericardium by effusion.

A friction may rarely be produced by the rubbing of two pleural surfaces together over the heart or between the pleura and pericardium, but both of these cease with the holding the breath.

FUNCTIONAL OR ACCIDENTAL OR HÆMIC MURMURS.

These are murmurs produced independently of any alteration in the state of the cardiac valves or orifices,

and are due to some condition of the blood as the result of which its particles are thrown into vibration more readily than in health. Hence they are also called hæmic murmurs. Such condition is generally accompanied by a watery state of the blood; for this reason they are also called anæmic murmurs. Whether it be this thinness which is responsible for the murmur or some accompaniment of such a state is not known. They occur in connection with various diseased states of the blood, as the infectious fevers, leucocythemia, chlorosis and the various anæmias. Functional murmurs have some features which aid in their recognition, although it is sometimes not easy to distinguish them from organic murmurs. Thus: 1. They are invariably systolic. 2. They are always soft in character. 3. They are most frequently basic in their situation, but they are also changeable in this respect. 4. Functional murmurs are unattended by the unequal distribution of the blood and the alteration in the size of the heart and of its cavities, which always, sooner or later, accompany the organic murmurs.

VASCULAR MURMURS.

In the examination of arteries the stethoscope is applied, for the carotid, over the inner border of the sterno-cleido mastoid muscle, on a level with the hyoid bone, or at the insertion of the sterno-cleido mastoid muscle into the clavicle and sternum; for the subclavian *behind* the clavicular insertion of the sterno-cleido

mastoid muscle; for the brachial, on the inner border of the biceps at the bend of the elbow, with the arm partially extended, and for the crural in the popliteal space. Care should be taken to apply the stethoscope very lightly, as the pressure itself will engender a sound which is called the acoustic pressure murmur. This may be made self-audible at almost any time with sufficiently quiet surroundings by pressing upon the artery in front of the ear.

Normal Arterial Murmurs.—If a stethoscope be thus lightly placed over the carotid or subclavian arteries, so as not to compress the vessels, two sounds are heard with each movement of the heart, the first corresponding to the systole of the ventricles and the expansion of the arteries, the second to the diastole of the heart and the contracting recoil of the arteries. The first is reasonably ascribed to the conducted aortic first sound,—the sound produced by the blood passing through the aortic orifice; also to vibration in the arterial wall caused by its distention. The second is undoubtedly the second sound of the heart conducted into the arteries. It is therefore feeble or absent in insufficiency of the aortic valves. The first of these sounds is occasionally heard in the abdominal aorta, more rarely in the brachial and femoral. The second sound is not thus conducted.

Abnormal Arterial Murmurs. — Abnormal sounds are conducted into the arteries in valvular disease of the heart, particularly aorticdisease, both obstructive and regurgitant, and rarely also in mitral

disease. In aortic regurgitation the first normal *arterial* sound is exaggerated so as to be heard in all accessible arteries, because of the rapid transition from extreme relaxation to extreme tension characteristic of this disease. In addition to this a second sound is heard in the femoral artery corresponding with the contraction of the artery. This is not to be confounded with a murmur occurring in the adjacent femoral vein caused by tricuspid regurgitation.

Finally, murmurs may arise in the arteries themselves from any causes which produce a change in the diameter of the vessel, such as aneurismal dilatation, congenital narrowing, or narrowing due to thrombi or to compression caused by adhesions, contraction of cicatricial tissue, morbid growths or inflammatory infiltration, or the pregnant uterus. Thus a murmur may occur in a branch of the pulmonary artery from pressure by a tubercular deposit or pneumonic infiltration, or enlarged bronchial gland, and a murmur may even be produced in the subclavian artery by a tubercular deposit at the left apex. A murmur in a branch of the pulmonary artery from such cause is intensified during expiration, while a murmur in the left subclavian from the same cause is said to be intensified by holding the breath at inspiration. Thyroid tumors in the neck also produce arterial murmurs by pressure. The **placental murmur** is a mixed venous and arterial murmur.

Venous murmurs are distinguished from arterial murmurs by their continuousness as contrasted with the intermittent arterial murmur. An acoustic pressure

murmur may be produced in any vein which is large enough, as the jugular and femoral, by pressing slightly upon it with the stethoscope, without however pressing so hard as to obliterate the blood current.

Murmurs independent of such pressure are sometimes heard in these large veins as the result of tricuspid regurgitation, but the principal pathological venous murmur is the **venous hum** or **bruit de diable.** It is frequently heard in chlorotic females over the bulb or dilatation of the internal jugular vein; also sometimes in the large intra-thoracic trunks, the superior cava and the innominata. It is best heard on the right side by turning the head as far as possible to the left and then placing the stethoscope above the right clavicle behind the sterno-cleido mastoid muscle. It is a **continuous** soft murmur resembling the humming of a top, and by its continuousness can be readily distinguished from an intermittent arterial murmur. This murmur cannot be regarded as always abnormal, since it is often heard in healthy individuals. Thus Winterich found it in 80 per cent. of the Bavarian cuirassiers whom he examined. Extreme loudness may be regarded as an indication of abnormality.

What is Kenrick sign?

— Gerhardt Sign

— Brennan Sign

PHYSICAL SIGNS OF THE DIFFERENT FORMS OF VALVULAR DISEASE.

MITRAL INSUFFICIENCY.

This is the most common of the uncombined forms of valvular disease. The valve leaks, the blood flows backward during systole from the left ventricle to the left auricle. The auricle first attempting to resist the backward flow, hypertrophies slightly, but soon dilates, and the blood is crowded backwards into the lungs which become engorged. The right ventricle in its efforts to push the blood through the engorged lungs, hypertrophies, and the pulmonary portion of the second becomes louder and sharply accentuated. The compensating effect of the hypertrophied right ventricle for a time arrests the mischief. At this stage, perhaps, begins the hypertrophy of the left ventricle, which in all cases of mitral insufficiency presents itself sooner or later, although at first the double outlet for the blood from the ventricle would seem to demand less strength of the left ventricle. The right ventricle, however, in its hypertrophied state, delivers more blood to the left ventricle, which demands more power to drive it on, hypertrophy results, and thus compensation is a while longer maintained. Sooner or later the tricuspid valve becomes insufficient, the blood regurgitates into the right auricle and thence into the great veins of the neck. The valves of these ultimately yield, the jugular pulse appears, and the general venous system is engorged.

In this engorgement the liver, stomach and kidneys share. Then comes transudation, dropsy, albuminuria. Among the latter phenomena in extreme cases are an enlarged, tender and pulsating liver, a symptom which is pathognomonic of tricuspid regurgitation, but a liver lifted by some pulsating agency behind it must not be confounded with the true pulsating liver.

Inspection discovers the apex-beat to the left of its normal position and perhaps a little lower down. It may be in the line of the nipple or even beyond it, and more forcible and diffuse than in health. The outward dislocation of the apex-beat is due to the enlargement of the two ventricles. An auricular impulse may be present to the left of the pulmonic area, and may be presistolic and active for the auricle, or systolic and passive for the auricle. A bulging præcordium may be looked for in young persons, and in advanced stages also a jugular pulse.

On palpation the apex-beat is found more forcible than normal, and there may be a pulsation near the ensiform cartilage caused by the systole of the enlarged right ventricle. Sometimes an intermittent systolic thrill is felt in the fourth interspace in the left mammillary line.

The radial pulse in the early stages is comparatively unaltered. Later it becomes frequent and irregular in volume. Appended, Fig. 14, is a sphygmogram of the pulse in advanced mitral insufficiency. It is of the type of the *pulsus parvus irregularis*.

Percussion discovers enlargement of both the relative

and absolute areas of dullness, upwards in the direction of the left auricle, downwards to the left and also to the right, the right border of the heart reaching at times the right border of the sternum.

Auscultation recognizes a systolic murmur in the mitral area, and conducted with various degrees of loudness into the left axilla and under the angle of the scapula. This direction of its conduction is the distinctive feature of this murmur. It is usually soft, but occasionally rough, more rarely musical. It is also

FIG. 14.

Tracing of Pulse of Mitral Insufficiency. (*Da Costa.*)

sometimes well heard to the left of the pulmonary cartilage, and rarely over the entire præcordium. Not always loud enough to be easily heard, it may be brought out by exertion on the part of the patient.

The second sound of the heart is sharply accentuated at the pulmonary interspace until the tricuspid valve fails, when the accentuation vanishes. The aortic second sound is less strong, corresponding with the less degree of hypertrophy of the left ventricle.

MITRAL OBSTRUCTION.

This lesion occurs as an uncombined or simple form of valvular disease in young persons, but is very much more commonly combined with regurgitation. The orifice is stenosed and the blood is restrained from passing freely into the left ventricle. The same backward effect is produced upon the left auricle, the lungs, the right ventricle and general venous circulation, but the left ventricle is not hypertrophied in simple mitral obstruction, because no extra muscular effort is called for. Theoretically, the left ventricle should even atrophy, but the absence of the enlargement is of great diagnostic value.

Inspection, consistently with what would be expected from absence of hypertrophy of the left ventricle, discovers little or no displacement of the apex. If there is any it is due to the hypertrophy of the right ventricle. Nor is the apex-beat increased in force. A left auricular impulse, pre-systolic, may be noted for the same reason as in mitral regurgitation, as may also a jugular impulse. The bulging præcordium occurs under like conditions as in mitral regurgitation, but is not often seen.

Palpation discovers the apex-beat without undue force, but it may be diffuse, and an impulse may be felt in the situation of the apex of the right ventricle. The most marked feature of palpation when present is the *pre-systolic thrill* usually felt in the fourth interspace, but it is not constant.

In moderate degrees of stenosis the pulse is not altered; in high degrees it is very small, from want of left ventricular power; also irregular, like that of mitral regurgitation.

FIG. 15.

Tracing of Pulse of Mitral Obstruction. (*Strümpell.*)

Percussion discovers cardiac enlargement in the direction of the left auricle and right ventricle, but not of the left ventricle.

Auscultation does not discover a diastolic murmur in every case of mitral stenosis, because of the feebleness of the auricular contraction, especially at the beginning. Often a murmur is deferred to the time of the auricular systole with which the diastole terminates, producing the described pre-systolic murmur. In the experience of the writer, the uncombined pre-systolic murmur has been so rare that he has failed to recognize the distinctive "bubbling" character pointed out by Flint, while modern hydraulics and acoustics do not permit the explanation that it is caused by a vibration of the free edges of the valves. The murmur when present is further compared to vibrating the letter *r* with the tongue, and is confined for the most part to the mitral area, though it may be conveyed upward, and it is even rarely heard posteriorly.

Accentuation of the second sound is marked and con-

fined to the pulmonary area, because there is no hypertrophy of the left ventricle. The second sound may also be duplicated, because of the want of synchronousness in the closure of the aorta and the pulmonary valves.

The murmur of mitral stenosis is sometimes difficult to distinguish from that of aortic regurgitation, but in the latter there is enormous hypertrophy of the left ventricle, which is wanting in mitral stenosis. The time of tricuspid stenosis is identical with that of aortic regurgitation, but it is heard in a different part of the præcordium,—in the epigastrium. Tricuspid stenosis may be associated with mitral stenosis, or insufficiency, or both.

MITRAL INSUFFICIENCY AND STENOSIS.

More frequently stenosis is an annexation to a previous insufficiency when we have the double mitral murmur, sometimes with difficulty divisible into its two parts. Extreme irregularity of rhythm and pulse, with frequency and smallness of the latter, conspicuous thrill, marked right-sided hypertrophy, and sharply accentuated pulmonic sound are characteristic.

AORTIC OBSTRUCTION.

This is a frequent form of valvular disease, and when uncombined with regurgitation the least dangerous. The aortic orifice is narrowed and prevents the free discharge of blood from the left ventricle into the aorta.

The ventricle attempts to overcome this, and its walls hypertrophy in proportion to the degree of resistance, and often for a long time compensate for the obstruction—until dilatation occurs, when the mischief really begins.

Inspection and palpation discover a forcible apex-beat beyond the normal situation and at varying distances in accordance with the degree of hypertrophy, while palpation adds occasionally a purring basic thrill with each beat of the heart when dilated hypertrophy is established.

The pulse is the *pulsus tardus*, slow in reaching its

FIG. 16.

Tracing of Pulse of Aortic Obstruction. (*Vierordt.*)

maximum volume which is small. It is frequent but regular, contrasting in the latter respect with the pulse of mitral disease. Fig. 16 is a sphygmogram.

Percussion discovers dullness downwards and laterally towards the left, since, as a rule, the enlargement is confined to the left ventricle.

Auscultation discloses a systolic basic murmur, loudest at the aortic area—second interspace at the right of the sternum—which is conducted distinctly into the carotids, and even sometimes along the course of the aorta, behind and to the left of the vertebral

column, into the popliteals and dorsal arteries of the feet. It is not, however, confined to this area, but may be heard over the entire præcordium. It is usually rough, but may be soft and musical. It is made louder by exercise. The second sound in its aortic factor is weak if the constriction be at all decided, because of the feeble recoil due to the small amount of blood in the aorta. The first sound is normal and somewhat louder and more prolonged than natural, because of the powerful contraction of the left ventricle.

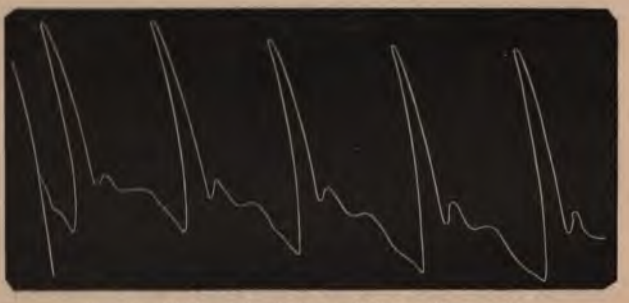
Roughness of the aorta due to atheroma, dilatation or narrowing of the vessels by pressure or otherwise, may also cause a systolic murmur, and so may roughness within the ventricle in the course of the outgoing column of blood; but these causes have generally a less positive effect upon the substance of the heart. In like manner anæmic or hæmic murmurs, which are always systolic and for the most part basic, may simulate aortic systolic murmurs, but these occur in young, delicate persons, of both sexes, and are often intermittent and without other effect on circulation. There may be roughness, too, in the pulmonary artery which can be localized to the left of the sternum.

AORTIC REGURGITATION.

The most serious and irremediable of the valvular diseases of the heart commonly met with; less frequent than aortic stenosis, but still not uncommon even uncombined. It is the lesion most frequently followed by

sudden death. The aortic valves are incompetent and the blood flows backward into the left ventricle during diastole. The ventricle seeking to restore the balance redoubles its energy, hypertrophies. The blood is thus driven into the aorta with great force, swelling the arteries to extreme fullness, which, however, falls away presently, because of the backward flow into the ventricle at the same time with the forward movement into

FIG. 17.



Tracing of Pulse of Aortic Regurgitation. (*Strümpell.*)

arteries and capillaries. This sudden falling away of the pulse, from extreme distention to collapse, is very characteristic of this form of valvular disease, and is called the "trip-hammer" or "water-hammer pulse," also Corrigan's pulse. It may even be visible to the casual observer in the exposed arteries, such as the carotid, temporal and radial, while the aortic beat, ordinarily beyond reach in the supra-sternal notch, may

sometimes be felt in this situation. The abrupt jerking impulse with sudden recoil is easily recognized by the finger, which, however, fails to find the pulse as strong and hard as would be expected from the appearance. On the other hand, it is soft and receding. A tracing of this pulse is found on the opposite page. It is the typical *pulsus celer*.

The tremendous systole of the ventricle may ultimately force the mitral valve to yield, and the compensation to be gradually lost *pari passu* with a growing dilatation. To this succeed the phenomena of mitral regurgitation, including hypertrophy of the right ventricle, which again comes for a time to the rescue, but weakens with the giving away of the tricuspid valve.

Inspection often discovers the præcordium prominent, with the apex-beat lowered and to the left, and the visible pulsation far beyond the normal situation of the apex, all confirmed by palpation, which discovers, too, sometimes a systolic thrill over the carotids and subclavians. A capillary pulse is also sometimes visible in the skin and mucous membrane. The former may be brought out by drawing a pencil lightly across the skin of the cheek or forehead and on the mucous membrane of the everted lower lip, as suggested by F. C. Shattuck, by pressing a glass microscopic slide against it.

Percussion reveals increased dullness to the left and downward.

Auscultation reveals a diastolic murmur, long and various in quality, but usually blowing and harsher than the aortic obstructive murmur. Its area of maximum

intensity is commonly at the aortic interspace, but not always, being sometimes heard most loudly at mid-sternum, sometimes at the fourth left costal cartilage, and even at the ensiform cartilage. Hence it may be mistaken for the mitral obstructive murmur and for the murmur of tricuspid disease, but both of these, be it remembered, is unaccompanied by hypertrophy of the left ventricle. The murmur is naturally directed downward along the sternum in the direction of the regurgitating column, but it is also heard in the direction of the great vessels of the neck though less loudly than the aortic systolic murmur.

AORTIC STENOSIS AND REGURGITATION.

This double lesion is a comparatively frequent one, indeed commonly regarded as the next in frequency after mitral obstruction, and therefore more frequent than either aortic stenosis or aortic regurgitation alone. It occasions a double basic murmur, systolic and diastolic, and is also a grave condition giving rise to the same dangers as aortic regurgitation, and the same enormous hypertrophy of the left ventricle.

TRICUSPID REGURGITATION.

Tricuspid regurgitation as a primary condition is extremely rare, and when present is probably the result of an endocarditis during fœtal life. More frequently it is one of the terminal events of mitral disease,

the tricuspid orifice yielding to the tension upon the right ventricle consequent upon the resistance to the movement of the blood through the engorged lungs. It is associated with the dilatation of the right ventricle which succeeds upon its hypertrophy if the patient live long enough. It is also one of the possible sequela of emphysema of the lungs and long standing fibroid phthisis. Its effects depending upon the venous circulation have already been detailed, p. 111.

In primary tricuspid disease with regurgitation, inspection and palpation discover an apex beat diffused about the normal area toward the epigastrium, and *percussion* detects enlargement toward the right edge of the sternum.

The systolic murmur thus engendered is invariably feeble and is heard almost alone in the tricuspid area just above and to the left of the ensiform cartilage. Occasionally only is the second pulmonic sound accentuated. There should be no confounding of this murmur with that of aortic regurgitation conducted towards the same situation nor with that of mitral regurgitation heard at no great distance, for the reasons named. To these must be added a difference in quality and pitch between the tricuspid and the mitral murmur. The jugular pulse is also more or less constantly associated with tricuspid regurgitation, which is further confirmed by the pulsating liver when present. The jugular pulse is systolic in time and does not appear until the valves situated at the opening of the internal jugulars into the innominate veins yield. These give way first on the

right side because the communication is more direct. It is sometimes not easy to distinguish a true jugular pulse from a false one, but pressure on the vein above the valves will cause the false pulse to disappear while the true pulse, coming from the right ventricle, will remain.

TRICUSPID OBSTRUCTION.

Still more rare is tricuspid stenosis, also when present a congenital defect associated with others. F. C. Shattuck has met one instance of tricuspid stenosis with mitral stenosis and regurgitation, along with adherent pericardium, hepatic cirrhosis and slightly granular kidney, confirmed by autopsy. In this case there was a pre-systolic tricuspid murmur observed for three years before death. This would, of course, be the murmur diagnostic of the condition, but frequently there is no murmur audible in connection with such a lesion found at necropsy. Theoretically, also, there should be enlargement of the right auricle.

PULMONARY OBSTRUCTION.

Pulmonary stenosis is a congenital condition occasionally seen in children, when it should furnish a systolic murmur in the pulmonary area, to the left of the sternum. The murmur may even be heard behind, between the shoulders. It is accompanied by hypertrophy of the right ventricle. There may be a basic thrill, as in aortic obstruction, but the pulse is unin-

fluenced. Compensation may be set up by means of a patulous foramen ovale, an open ductus arteriosus or interventricular communication. The invariable association of cyanosis due to venous obstruction, and of attacks of dyspnœa, complete the picture and aid greatly in the diagnosis. Anæmic murmurs at the same time and place are unaccompanied by cyanosis.

PULMONARY REGURGITATION.

Simple pulmonary regurgitation is scarcely known, but it is easy from what has gone before to deduce the physical signs which are to be expected. A diastolic murmur heard in the pulmonic area, hypertrophy of the right ventricle, jugular pulse, venous congestion and cyanosis.

CONGENITAL DEFECTS.

Congenital defects in the cardiac valves and orifices deserve a passing notice. They may be the result of endocarditis during fœtal life or of arrest of development. Their most frequent seat is the right heart and the most frequent form is stenosis of the pulmonary orifice, the effects and signs of which have already been considered. Another is a permanently patulous foramen ovale; or there may be a defect of the septum of the ventricles, or a communication between the aorta and pulmonary artery—a persistent ductus arteriosus—or between the aorta and the vena cava or right auricle.

All of these intercommunications produce murmurs difficult to separate, and it is, after all, by attention to the general condition that the defect is recognized. The patient, a child of arrested development, more or less permanently cyanosed, with continued embarrassed breathing, all of these are symptoms which point to the congenital defect. If there be added to these a persistent loud murmur at the base of the heart without other signs or symptoms of valvular disease, this may be due to congenital defect.

RELATIVE FREQUENCY AND DANGER OF VALVULAR DEFECTS.

The order of frequency of simple chronic valvular defects, as given originally by Walshe, and perhaps as nearly correct as can be arrived at, is as follows:—

1. Mitral regurgitation.
2. Aortic obstruction.
3. Aortic regurgitation.
4. Mitral obstruction.
5. Tricuspid regurgitation.
6. Pulmonary obstruction.
7. Tricuspid obstruction,
8. Pulmonary regurgitation,

} scarcely known.

The same author estimates the following as the order of frequency of the combined affections:—

1. Mitral regurgitation and aortic obstruction.
2. Aortic obstruction and regurgitation.

3. Mitral regurgitation and aortic regurgitation.
4. Mitral regurgitation, aortic obstruction, and regurgitation.
5. Mitral obstruction and regurgitation.
6. Mitral obstruction and aortic obstruction.(?)
7. Mitral obstruction and aortic regurgitation.(?)

The relative gravity, beginning with the most serious, is also given by Walshe, as follows:—

1. Tricuspid regurgitation.
2. Mitral obstruction and regurgitation.
3. Aortic regurgitation.
4. Pulmonary obstruction.
5. Aortic obstruction.

It will be remembered, however, that I have said that aortic regurgitation is the most irremediable of the valvular defects, at least of the more common forms, and the most serious from the standpoint of tendency to sudden death. It will be noted that no place is assigned by Walshe to mitral obstruction alone, and it is indeed difficult to assign the final position of this lesion. In this view most clinicians agree.

ACUTE ENDOCARDITIS.

The two well-acknowledged forms of endocarditis, **simple** and **infectious** or ulcerative, furnish no distinctive physical signs by which they can be recognized one from the other. It is rather by the history and symptoms that such distinction is made, the

almost invariable succession of the former upon rheumatism and of the latter on some coexisting infectious state being valuable aids.

Both have their most frequent site on the left side, the most vulnerable, and in the mitral leaflets. A systolic mitral murmur, in the course of a rheumatism, means almost invariably an endocarditis. The aortic leaflets may also be the seat of inflammation, though more rarely, when a basic murmur is the consequence. But not every aortic murmur in the course of rheumatism implies endocarditis, as the condition of the blood predisposes to a hæmic murmur. Unless there has been previous valvular disease, there is no enlargement, so that neither palpation, inspection nor percussion gives any information.

PERICARDITIS.

The only distinctive physical sign in the first stage of pericarditis is the friction sound, described on p. 104. In addition the impulse may be strong.

The second stage, or that of effusion, has usually, but not always, signs discoverable to inspection and palpation. The precordium may be bulging and the interspaces obliterated, and the impulse undulating, tumultuous and indistinct. Percussion furnishes the most striking change. The area of dullness is enlarged and peculiarly enlarged. It becomes rudely triangular, with the apex towards the inner end of the left clavicle and the base as low as the seventh rib, and extending in extreme

cases from nipple to nipple. Auscultation confirms palpation, the impulse is feeble, indistinct and often tumultuous. The heart-sounds are indistinct and best heard at the top of the sternum.

The third stage consists of a gradual return to the normal state of affairs, which may be by the intermediation of a *friction redux* or not. Adhesions may result between the heart and the sac, embarrassing its movements permanently, and producing retraction of the chest-wall with systole. On the other hand, necropsy has often revealed close adhesions between the heart and the pericardium which were not suspected during life. Permanent roughening by organization in chronic pericarditis may produce permanent friction sound.

Hydropericardium, as a part of a general dropsy, is a rare condition, and furnishes the same physical signs as the inflammatory effusion.

DISEASES OF THE MYOCARDIUM.

The heart is subject to alterations in its muscular substance independent of valvular defect. Simple hypertrophy, fatty infiltration, and fatty metamorphosis or true fatty degeneration, are the most important. Myositis, abscesses, and aneurisms of the walls of the heart are such rare conditions that they need only to be mentioned in passing, especially as there is no way to recognize them before death.

Hypertrophy of the left ventricle, without valvular disease, is always the result of obstruction to the

movement of the blood through the aorta beyond the valves, or to some demand for compensation. The most common remote cause is chronic Bright's disease. Any variety of chronic Bright's disease may cause it, but it is most frequently associated with chronic interstitial nephritis. We have nothing to do here with the mechanism of its production except to say that it seems likely that it is in some way compensatory. Atheroma and aneurism of the aorta are attended by less degrees of hypertrophy, also compensatory, because of the loss of the elastic force in the arteries, requiring additional power on the part of the heart muscle.

Inspection and palpation furnish much the same information as in hypertrophy of the left ventricle from valvular disease. Percussion shows enlargement to the left and downwards. To auscultation there is no murmur but a distinctive intensification of the aortic second sound is heard, quite characteristic, and itself of great diagnostic value.

Pure hypertrophy of the right ventricle is the result of emphysema of the lungs, and sometimes to a less degree of fibroid disease of the lungs, compression of the lungs by effusion or adhesion, or of any cause which resists the movement of the blood through the lungs. We have here the signs of enlargement in the direction of the right heart also without murmur, but with sharp accentuation of the second sound at the pulmonary interspace to the left of the sternum.

General hypertrophy or physiological hypertrophy or symmetrical hypertrophy of both sides of the

heart may be brought about by severe muscular exercise, demanding extra nourishment. Exophthalmic goitre is often accompanied by the same condition, due to over-nourishment the result of vaso-dilator influence on the blood-vessels.

Dilatation of the Heart, either of its right or left ventricle, may occur independent of valvular disease. A heart cavity is said to be dilated when it is enlarged out of all proportion to the thickness of its walls, even though the latter may be somewhat thicker than normal. Commonly, however, the walls are thinner or no thicker than in health, and when the muscular wall is thickened while the cavity is enlarged we commonly speak of the condition as **hypertrophy with dilatation.** The term **simple dilatation** is used to indicate undue enlargement of the cavity while the walls remain of normal thickness; **attenuated dilatation** where the walls are thinned.

Dilatation without valvular disease occurs in conection with vesicular emphysema when, of course, it is in the right heart, and succeeds hypertrophy. Whatever causes obstruction to the outward flow of blood from a ventricle may cause dilatation, which is always, however, preceded by hypertrophy. Aneurism is such a cause, therefore, for the left heart. Acute infectious disease may also cause it, and sometimes no cause is discoverable.

Inspection and palpation discover a diffuse feeble impulse and the pulse is weak. Percussion elicits signs of enlargement while auscultation finds the sounds

generally feeble and indistinct. I speak now of dilatation without valvular disease. When valvular disease is present its signs are superadded.

Fatty infiltration or obese heart is often a part of the condition of general obesity, and has the same causes. It is something very different from the true fatty heart in which the muscular fasciculi are converted into granular fat. In the fatty infiltration the fat first covers the surface of the heart, then insinuates itself between the fasciculi, and although these are never themselves invaded, in extreme cases they undergo degeneration and atrophy from the pressure of the intervening fat. The heart is therefore not only embarrassed by the fat around and between its fibres but the integrity of its essential substance may also be impaired by interference with its nutrition, and occasionally death results from sudden failure, just as in true fatty metamorphosis.

Such a heart is usually somewhat symmetrically enlarged, but the heart sounds are feeble and indistinct, and the same is true of the impulse. There are of course no murmurs unless the condition be complicated with valvular disease.

Its recognition is based chiefly on the association of the symptoms of cardiac weakness with general obesity.

True fatty metamorphosis consists in an actual substitution, to a greater or less extent, of the muscular substance of the heart by granular fat. Such a heart muscle is soft and flabby and its contraction power is greatly impaired.

The physical signs of such a condition are not at all distinctive. There is feebleness of sounds and impulse. The latter as well as the pulse may even be inappreciable. There may be some enlargement of the heart, the result of dilatation of the soft and yielding muscle. Nor is there murmur unless there be valvular disease. It is rather by watching a case over a considerable period of time that the truth is arrived at. Treatment is without result and its total inefficiency is an aid in diagnosis. Fainting is frequent and sudden death the usual termination.

Acute myositis associated with acute rheumatism or fever may be a cause of fatty degeneration, but there is no way to determine its presence.

THORACIC ANEURISM.

Thoracic aneurism occurs in the arch of the aorta, in its ascending, transverse and descending portions, and in the thoracic aorta below the arch. The greater frequency of aneurism in the male sex and during early middle life may be mentioned in passing.

Inspection does not always discover changes, but if the sac grows outwardly, sooner or later a **swelling** makes its appearance, to the right of the sternum if in the ascending limb, possibly raising a rib or the end of the clavicle; above and behind the sternum, if in the transverse portion, raising the manubrium or boring its way through it; and to the left of the sternum if in the descending limb of the arch. Such a tumor may **pul-**

sate or not. The aneurism is, as it were, a rudimental heart, dilating with every jet of blood that is shot into it so long as the wall is yielding. Should this property be lost, either as the result of calcification, or the lining of the sac with successive layers of coagulum, such dilatation becomes impossible, and pulsation does not occur. The pulsation is, however, of great importance in the diagnosis. When present it is synchronous with the systole of the ventricles. The heart itself is sometimes displaced downward, as may be recognized by the lowering of the apex.

If the aneurismal tumor press upon the great veins of the neck there may be **venous engorgement** on one side of the neck or both, according as the innominate of one side only is compressed or the descending cava itself.

Palpation also discovers the **impulse** of the aneurism if it is visible, and sometimes when it is not visible. This beating is somewhat peculiar, being *expansile*, and by this peculiarity differs from the rising of a tumor over a blood-vessel. A **thrill** is also often felt, a vibration in the walls of the sac caused by the whirl of the blood in it. It is by no means, however, invariable, and it may come and go.

Percussion over the swelling of an aneurism invariably gives **dullness**, varying greatly in extent, and sometimes altogether absent. On the other hand, the adjacent lung may be compressed by an aneurismal tumor, and the area of dullness thus extended.

Auscultation is no exception, as compared with the

other modes of physical investigation, in the inconstancy of its results; sometimes furnishing the most distinctive signs, while at others it is totally negative. The **sounds** heard by the ear in listening over an aneurism are various. Sometimes they are like those of the heart, the first intense and prolonged, the second fainter and shorter. Sometimes but one sound is produced, corresponding with the first sound over the ventricles, but more intense. But the sound which is commonly sought over an aneurism is the **murmur** or **bruit**, supposed to be caused by the rush of the blood through the sac. As such it is usually single and systolic, though it may be double, or only diastolic. It is sometimes musical. The murmur is, however, often absent, and substituted by the above described sounds. The mechanism of these sounds is not settled. One may be produced at the entrance of blood into the sac, and the other at its exit, or the second sound may be conducted into the sac, or one may be an aortic regurgitant murmur.

But any one or all of these signs may be wanting. Particularly is this the case where the aneurism occurs just after the aorta has left the heart. The most valuable are the pulsation, distinct and separate from that of the heart, and the sounds separate, and distinct from those of the heart, or, as graphically put by Da Costa, "two hearts, apparently, each with its own distinct beat, its own distinct sounds." *

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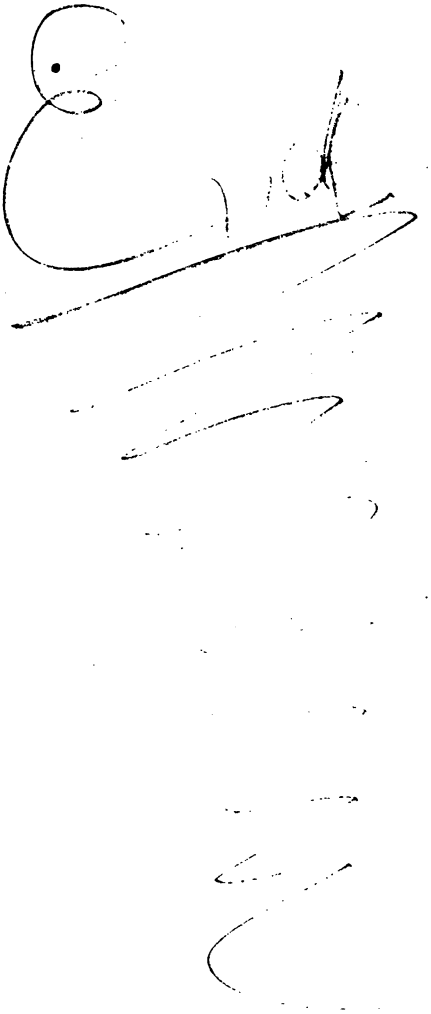
* Op. citat., p. 451.



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